



Banking and NBFC's Part in Improving the Small and Medium-Sized Enterprise (MSME) Sector in Andhra Pradesh

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ABSTRACT

Importance of micro, small, and medium enterprises (MSME) to India's economy by creating ample job opportunities and contributing to social development. It caters to many of the population, offering a wide range of goods and services, bolstering the nation's wealth. However, this sector faces challenges due to inadequate financial support and capital. Although banks, non-banking financial institutions, and microfinance companies are extending some assistance, there is still a need to understand their specific contributions in allocating funds to foster the MSME sector's growth in Andhra Pradesh. It uses secondary sources to address a wide range of topics including commerce, advertising, HR, operations, and export prospects. Obtaining cash for working capital requirements in a timely manner is one of the many obstacles encountered by MSME units. Other challenges include a lack of advisory assistance, cumbersome paperwork, up-to-date technology capabilities, and need-based research initiatives. The paper goes on to provide policy-based solutions to these problems that limit the expansion possibilities of MSME units. This study aims to delve into the role these financial entities play in facilitating the development of MSMEs in Andhra Pradesh.

Keywords: Bank, challenges, development, financial institutions, Microfinance, MSME.



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INTRODUCTION

Key programs in Andhra Pradesh that have helped micro, small, and medium-sized enterprises (MSMEs) flourish include the Andhra Pradesh State Financial Corporation (APSFC) and other state government schemes. While acknowledging the vital role of banks and NBFCs in supporting this growth, it's crucial to understand their specific contributions to developing the MSME sector in Andhra Pradesh. Over the past five decades, India's MSME sector has become a dynamic force within the nation's economy. Its growth suggestively subsidizes to economic and social progress by fostering entrepreneurship and creating jobs at relatively low capital investments. SMEs are pivotal in ensuring a balanced industrial development across the country. These enterprises are diversifying into new sectors and offering various products and services to meet local and global demands. This research aims to lean-to bright on the precise roles played by Banks and NBFCs in nurturing the MSME landscape.

MSME protagonist in Economy

In India, MSME, or micro, small, and medium-sized businesses, are vital to the country's economy.

Employment Creation: MSMEs play a main role in India's employment progress. They make up many job openings, especially in semi-urban and pastoral regions. Their capacity to create jobs at a cheaper cost of capital is essential for resolving issues with joblessness.

Economic Contribution: The nation's GDP is significantly boosted by this industry. Even though they operate on a much smaller scale than huge firms, MSMEs produce a significant amount overall across various industries, which greatly helps drive the prosperity of India.

Promotion of Entrepreneurship: MSMEs encourage entrepreneurship by giving people with creative ideas but little capital a place to start and expand their enterprises. They serve as breeding grounds for fresh ideas and profitable ventures.

Regional Development: MSMEs are essential to the promotion of equitable territorial growth. They reduce regional disparities by operating in various sectors and frequently thriving in areas where bigger businesses aren't always viable.

Export Promotion: In order to boost exports, it is crucial for small and medium-sized firms to thrive. The production and export of a wide range of goods and services considerably increase India's export revenue and foreign exchange reserves.

Inclusive Growth: By creating chances for industry and business ownership, the MSME industry strengthens economically disadvantaged and excluded areas of society, hence promoting equitable development.

Integration of Supply Networks: MSMEs are frequently essential elements of supply networks in both home and foreign markets. They contribute to the general efficiency and effectiveness of these sectors by serving as providers to bigger businesses.

LITERATURE REVIEW

We used graphs and statistical analysis to verify and check the data. It turns out that the banking industry significantly impacts Gujarat's small enterprises, which primarily rely on bank loans. The study shows these small businesses may flourish with low-interest financing and professional advice. This study aims to determine how Gujarati banks can facilitate the expansion of small businesses. The catch is that half of the respondents encountered difficulties obtaining those bank loans, and most of them had to wait a lengthy period[1]. The research revealed several difficulties facing small and medium-sized enterprises in Magetan Regency, including rivalry between



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related businesses, the potential for new entrants, replacement products to overtake the market, and the impact of suppliers' and customers' negotiating power[2]. This paper aimed to uncover what's holding back MSME growth, diving into many academic articles. What popped up was a big issue: getting money to grow. Reports pointed to the government trying various ways to simplify getting cash. But banks? They're not too thrilled about lending to these businesses. Seems they don't see it as a profitable move.[3] According to the report, addressing the shortage of human resources would include taking a new route, such as involving the manufacturing sector's neighbours through social enterprise projects[4]. The nation's MSME market is one of the most vivacious and thriving in the country's economy. It has been expanding gradually as more new buildings are constructed, a wider range of goods are brought to the market, and employment is generated. This industry plays a vital economic role, contributing significantly to the country's GDP, industrial output, export revenue, regional growth, and social stability. Even with the efforts of several ministries, MSME units continue to face several difficulties[5]. Key study themes that are essential for small and medium-sized small island economies were identified by the review. It was proposed that to understand economics in these contexts fully, it is crucial to focus on how characteristics at the national level influence the relationships among competitiveness elements such as innovation, social equity, management of people, and creativity[6]. While many studies have examined the effects of government bank loans on small and medium-sized and the economy, my research fills the gap created by these institutions' unwillingness to lend to small enterprises. I aim to expedite and streamline the financing process for micro, medium-sized enterprises. In addition, I propose a more strategic lending path via NBFCs to provide SMEs with a significant advantage [7].

India's national and state governments are paying close attention to small and medium-sized enterprises, or MSMEs. Their economic contribution is considered significant, and they possess a robust export potential, as they deal with over 6000 different types of goods[8]. A startling statistic is that, except for the defence and public administration sectors, about 78% of the 63.3 million businesses that produce these items are not in the farming industry. And here's the thing: a single owner who also serves as the only employee manages about 90% of them[9]. Thus, creating regulations for this heterogeneous group is difficult. Any announced rules will significantly affect several industries, including biotech, plastics, electronics, power, solar energy, pharmaceuticals, military hardware, and more[10].

Aim of the study

This research examines how banking and NBFCs help the MSME sector grow. And we're diving deep into the Andhra Pradesh district of Vizianagaram for this study.

METHODOLOGY

We gathered info for this study from two sources: stuff we found directly from selected folks involved (that's the primary data), and other info already out there from various sources (those are the secondary ones).

In this study, we focused on Vizianagaram and picked out folks from current and new businesses in the and medium, small and micro sectors. You can find the details in following

Analysing and Interpreting The information**Phases of a firm's lifespan**

Among the businesses in the area, the majority were in the upkeep stage, although a few are now growing. Among the fewest companies in the survival phase was this one. Of the fifty organisations, twenty-nine were micro firms, with seven in the growing phase, three in the maintenance phase, eleven in the promotion phase, and eight operating as preservation enterprises[11]. Nineteen small firms participated; seven were growing, four were in the pre-profit phase, and eight were still operating. One medium-sized organisation was in the expansion stage and the other was in the maintenance stage when they participated in the research[12]. Table **Lists the phases of the lifespan of these firms.**



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Service-oriented businesses led in the early phases of expansion and growth, but as Table 4.1.2 shows, manufacturing companies predominated in the subsequent decades.

Challenges in Accessing MSME Finance

Companies' current and historical experiences with funding-related problems were the focus of the poll. We used a scale where 1 was very easy, 2 was mid-level, and 3 was quite difficult[13]. A percentage was determined by comparing the number of companies that found a particular problem tough to the number of firms that found at least one issue challenging throughout all stages. The findings are shown in Table 5.1.

Finally, several challenges stand in the way of micro, small, and medium-sized business (MSMEs) growth. Each problem pertaining to funding was seen as a difficulty by at least one business throughout both the launch and expansion periods[14]. Issues with infrastructure, labor, compliance with labor standards, or company registration do not prevent businesses in the survival phase from acquiring capital. Enterprises can easily access the necessary infrastructure and labor force. Companies with strong current accounts do not see this as a problem. Issue[15]. The difficulties encountered by the MSME at several points in the process of obtaining the funding are detailed in Table 5.2.

Loan processing times offered by banks and NBFCs

During the maintenance period, banks took almost 2.5 times longer than NBFCs to process credit requests from MSMEs. The average time needed for microfinance institutions was estimated to be one week. Whether a company is brand new or well-established and expanding, the time it takes for a bank to execute a loan application is usually the same[16]. On average, NBFCs were faster than banks in processing loan requests, but their current processing time is almost four times longer than it was during the boom. Because of the small number of firms that have reported on this metric, it may be premature to draw firm conclusions regarding microfinance institutions. The extra due diligence that banks and NBFCs do might be the reason why businesses have longer processing delays throughout the expansion and maintenance phases[17]. Average Time Needed to Get a Loan from Different Financial Institutions (Banks, NBFCs, and MFIs)

Processing fees for loans at large financial organisations

Only one firm revealed increased interest in its microloan during the survival round. More companies reported on the growth and sustainability phases than the start-up and survival periods. In the early days of business, banks could handle loans for tiny amounts of money[18]. Despite similar median values, bank loans to developing firms had processing expenses that were, on average, about twice as expensive as those to sustaining businesses. While NBFCs' average processing costs for loans were almost non-existent for startups, they jumped to roughly three times that amount for well-established enterprises. The average processing price for loans from microfinance institutions was much greater when comparing enterprises in the sustenance stage to those in the survival stage [19]. More firms who reported using banks for finance nevertheless said that they would still contact them, despite the increased processing costs. When it came time for growth and maintenance, firms would have been better off going with non-bank financial institutions (NBFCs), as shown in Table 6.3. Fees for Processing Loans at Banks, NBFCs, MFIs, and Other Major Financial Institutions [20].

Findings

- During the maintenance phase, businesses have many problems.
- These include complicated procedures, difficulties in obtaining collateral or guarantees, a lack of information about available schemes, and lengthy loan application processes.
- Banks and Non-Banking Financial Companies (NBFCs) play a crucial role in shaping the growth and success of Andhra Pradesh's MSMEs sector.
- The state's economy benefits from its services and financial support, which aid in business startup and growth, technological upgrade, entrepreneurship promotion, and overall economic strength.





CONCLUSION

These organisations give MSMEs a safety net by offering financial products and credit guarantee programs that guide them through difficult and hazardous situations. Their contribution to financial advice services is crucial in helping companies make educated choices about strategic planning, risk management, and investments. Although these banks play a vital role in providing direct financial aid, their influence goes beyond lending. They serve as vital stimulants for the technical and infrastructural growth of the MSME sector, enhancing its competitiveness. As with the previous stages, there were several obstacles to overcome, such as the requirement to furnish collateral for loans and a greater awareness of the available MSME funding schemes. It was unexpected to find that lending institutions required additional collateral to support well-established enterprises' goodwill and market credibility.

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Table 3.2.1 Size of Sample

Name of the enterprise	No.of respondents
medium	2
small	19
Micro	29
Total	50

Table 3.2.2 Stage-by-stage analysis of the lifecycle

stage of establishment	type of enterprise			total
	micro	small	medium	
Start – Up (< 3 years)	11	8	1	20
Survival (3- 6 years)	9	5	1	15
Growth (7 – 9 years)	6	4	0	10
Substance (> 10 years)	3	2	0	5

Table 3.2.3 Arrangement of samples by industry

Stage	Industry	
	Manufacturing	Service
Startup	13	7
Survival	9	4
Growth	5	6
Substance	4	2
Total	31	19

Table 4.1.1 Steps in the Life Phase of the Sampled Businesses

Stage of the enterprise	Small(N=19)	Micro(N=29)	Medium(N=2)
Startup (<3 years)	47.36842	37.93103	50
Survival (3 to 6 years)	10.55556	27.58621	50
Growth (>6 years)	28.42105	24.13793	0
Substance (> 10 years)	7.037037	10.34483	0





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Table 4.1.2 Industries in Which the Representative Firms are Distributed

Stage of enterprise→ Enterprise sector ↓	Startup (<3 years)N=9	Survival(3- 6years)N=6	Growth(>6 years)N=11	Substance (> 10 years)N=5
Manufacturing	29.03	19.35	35.48	16.13
Service	47.37	31.58	57.89	26.32

Table 5.1 Challenges in Accessing MSME Finance

Challenges	startup stage (N=20)	survival stage (N=13)	growth (N=11)	substance (N=6)
High service charges for the loan process	65.6	34.5	45.67	78
Difficulty in completing the documentation process	76.7	79	87.8	0
Registration of enterprise	34.5	75.7	56.76	0
lack of knowledge about available schemes	65.45	83.6	76.78	56
high rates of lending	84.56	34.6	67	89
scarcity of skilled workers	67.7	12.4	87	34
lack of availability of infrastructure	62.34	51.3	34	54.78
lengthy process for loan application	76.98	54.76	84	45.65
Tax-related issues	43.69	45.67	54	34.45

Table 5.2 The difficulties encountered by the MSME at several points in the process of obtaining the funding are detailed

Challenges	survival stage (N=13)	startup stage (N=20)	growth (N=11)	substance (N=6)
The lending procedure incurs high service costs.	Y	Y	Y	Y
Having trouble getting the paperwork done	Y	Y	Y	Y
Registration of enterprise	Y	N	Y	Y
lack of knowledge about available schemes	Y	Y	Y	Y
a high percentage of loans	Y	Y	Y	N
scarcity of skilled workers	Y	Y	N	N
lack of availability of infrastructure	Y	Y	N	N
lengthy process for loan application	Y	Y	Y	N
Tax-related issues	Y	Y	N	Y

Source: Calculated Data

Y=Yes; N=No.

Table 6.1 Loan processing times offered by banks and NBFCs

Stages Of Enterprise	Financial Source	Mean	Minimum	Maximum	Median	No. of Respondents
Startup	Bank	118	5	365	55	5
	NBFC	7	2	15	16	3
	MFI	8	8	8	8	2
Survival	MFI	1	1	1	1	1
Growth	Bank	25	8	85	23	24
	NBFC	5	4	11	7	6
Sustenance	Bank	43	24	65	34	35
	NBFC	23	17	25	35	5
	MFI	5	5	5	5	5





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Table 6.3 Processing fees for loans at large financial organisations

Stages Of Enterprise	Financial Source	Mean	Minimum	Maximum	Median	No. of Respondents
Startup	Bank	2.5	2	6	2.5	3
	NBFC	0.00	0.00	0.00	0.00	1
Survival	MFI	9	9	9	9	1
Growth	Bank	70	8.31	220	35.35	18
	NBFC	26	22.08	23.17	21.09	7
Sustenance	Bank	32.07	4.87	160	26.34	14
	NBFC	5.66	1.35	11.45	4.56	4
	MFI	1	1	1	1	1

Source: Calculated data





Social Media and Library Outreach: Leveraging Digital Platforms for Community Engagement

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ABSTRACT

Social media has transformed the landscape of communication and community interaction in the digital era, offering libraries a distinctive chance to connect with wider audiences. Traditionally seen as physical entities, libraries are now expanding their services and outreach into the online space through platforms like Facebook, Twitter, Instagram, and YouTube. This article investigates how libraries are utilizing social media for outreach efforts, delivering real-time updates, hosting virtual events, and providing educational resources. Additionally, it addresses the challenges that come with social media usage, such as content management, digital literacy, and audience engagement, while presenting best practices for libraries to enhance their social media strategies for improved outreach and community participation.

Keywords: Social Media, Library Outreach, Community Engagement, Digital Literacy, Content Management, Digital Library Services, Public Libraries, Social Media Marketing, Educational Resources, Audience Engagement, Digital Communication

INTRODUCTION

The swift expansion of social media has significantly altered the manner in which organizations engage with their audiences, and libraries are no exception to this trend. Once regarded as serene, scholarly environments centered on physical collections, libraries have adopted digital communication strategies to maintain their relevance in a highly interconnected society. Social media platforms enable libraries to connect with users beyond their physical locations, interact with communities in real-time, and provide a variety of online services, including the promotion of reading



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initiatives and the hosting of virtual events. In response to the growing demand for digital resources, particularly due to global circumstances such as the COVID-19 pandemic, libraries have had to adapt rapidly to serve remote users effectively. Platforms like Twitter, Instagram, Facebook, and LinkedIn have emerged as essential tools for libraries to sustain their outreach efforts, ensuring that patrons remain informed, connected, and engaged. This article will explore the significance of social media in library outreach, its influence on community engagement, and the ways in which libraries can leverage these platforms to broaden their services and strengthen relationships with their patrons.

Objectives

- 1. Enhance community involvement through social media channels:** Broaden the library's outreach and strengthen connections with both local and distant audiences by maintaining regular interactions on social media.
- 2. Advertise library offerings and activities:** Utilize social media as a means to showcase library programs, events, collections, and services to a wider audience.
- 3. Improve digital literacy skills:** Share educational resources via social media that assist users in navigating the digital landscape, focusing on research techniques, information literacy, and safe online practices.
- 4. Encourage partnerships with local organizations:** Use social media to collaborate with nearby schools, cultural entities, and community groups to promote joint initiatives and services.
- 5. Deliver immediate updates and online services:** Keep patrons informed about library services, operating hours, closures, and announcements in real time through social media, while also providing virtual programming to complement in-person offerings.
- 6. Cultivate inclusive online communities:** Leverage social media platforms to create welcoming spaces for all community members, particularly by amplifying diverse voices and addressing topics pertinent to underrepresented groups.

The Role of Social Media in Library Outreach

1. Reaching Varied Audiences

One of the most significant advantages of social media is its capacity to connect with a wide range of audiences. Unlike conventional library communication methods, such as newsletters or bulletin boards, social media enables libraries to engage with individuals who may never set foot in the library. This includes remote learners, busy professionals, and those who may feel uneasy in traditional library environments. By leveraging platforms like Instagram and Twitter, libraries can customize their content to appeal to various demographic segments. For instance, academic libraries might provide research guidance or online resources tailored for students and faculty, while public libraries could emphasize community events, children's activities, or digital literacy initiatives.

2. Advertising Events and Services

Social media serves as a powerful medium for advertising library events, programs, and services. Through posts, stories, and live broadcasts, libraries can keep their audiences updated on upcoming activities such as book clubs, author discussions, workshops, and new acquisitions. Notably, platforms like Facebook and YouTube offer features for hosting events, allowing libraries to organize virtual gatherings that patrons can join from anywhere. Virtual programs, including webinars, online reading groups, and live storytimes, have become increasingly popular, especially when in-person gatherings are not possible. By promoting these events on social media, libraries can reach a broader audience compared to traditional in-library programs, and recordings can be made available for later viewing.

3. Providing Educational Resources and Digital Literacy

A significant function of social media is the distribution of educational materials and resources. Numerous libraries leverage social media to highlight their digital offerings, including e-books, databases, and online tutorials. Platforms such as YouTube enable libraries to create and share instructional videos on research techniques, accessing electronic resources, and utilizing library tools effectively. Additionally, libraries are vital in promoting digital literacy. Social media serves as a platform for libraries to instruct users on how to critically assess online information, steer clear of misinformation, and responsibly use digital tools. By consistently sharing tips, articles, and educational resources, libraries contribute to the improvement of digital literacy within their communities.



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4. Collaborating with Community Partners

Social media serves as a valuable tool for libraries to engage with various community organizations. By partnering with local schools, museums, and cultural entities, libraries can leverage social media to advertise joint events, co-host virtual programs, and foster robust community relationships. For example, public libraries may team up with local authors or artists to facilitate online workshops or live Q&A sessions on platforms like Instagram or Facebook. Similarly, academic libraries can collaborate with different departments within their institutions to highlight research workshops, open access resources, and other educational initiatives. These partnerships enable libraries to enhance their influence and cultivate a sense of community among their patrons.

Challenges in Social Media Outreach for Libraries

1. Content Management

One of the primary obstacles libraries face in managing their social media outreach is the ongoing need to produce engaging and pertinent content. Social media platforms demand frequent updates to keep users interested, which can be a time-intensive process. With often limited personnel assigned to social media management, libraries may find it challenging to sustain an active presence across various platforms. To enhance their social media strategies, libraries can develop a content calendar and utilize automation tools like Hootsuite or Buffer. Nevertheless, it is crucial for libraries to strike a balance between automated posts and real-time engagement, ensuring that their social media interactions remain genuine and responsive.

2. Targeting the Appropriate Audience

Although social media has the potential to reach large audiences, libraries may encounter difficulties in identifying and engaging the right users. For instance, a public library's demographic may encompass both tech-savvy young adults and older individuals who are less acquainted with digital technologies. Libraries need to customize their messaging and select the appropriate platforms to effectively connect with their target audience. Academic libraries, for example, might leverage LinkedIn for professional networking and Twitter for scholarly discussions, while public libraries could focus on Instagram or Facebook for broader community engagement.

3. Addressing the Digital Divide

Despite the increasing use of social media, not all members of the community have equal access to digital resources. The digital divide—where certain groups lack reliable internet access or digital devices—presents a challenge for libraries aiming to engage all community members online. Libraries should be aware of this divide and explore alternative methods to connect with users who may not be active on social media, such as through telephone hotlines, printed newsletters, or collaborations with local community organizations.

4. Engagement Metrics and Feedback

Evaluating the effectiveness of social media outreach presents challenges for libraries. Although metrics such as likes, shares, and comments can offer some understanding of engagement levels, they often fail to reflect the comprehensive impact of social media efforts. Libraries may find it difficult to determine how these outreach activities correlate with increased library usage or enhanced community involvement. To improve their strategies, libraries can gather feedback from patrons and utilize social media analytics tools. Additionally, engaging users through surveys, polls, or Q&A sessions on social media can provide valuable insights into the needs and preferences of the community.

Opportunities for Libraries in the Social Media Landscape

1. Digital Library Offerings

Social media presents libraries with the chance to enhance their digital offerings. Platforms like Facebook Live and YouTube serve as venues for virtual workshops, story times, and interactive Q&A sessions, allowing libraries to connect with patrons who are unable to visit in person. Additionally, libraries can utilize Instagram Stories and Twitter threads to disseminate research tips, recommend new books, and share various educational resources.

2. Cultivating Inclusive Communities

Libraries can leverage social media to nurture inclusive online communities. By showcasing diverse authors, celebrating cultural milestones, and sharing content that resonates with marginalized groups, libraries can create





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inviting environments for all users. Direct engagement with patrons through responses to inquiries and addressing concerns can further enhance the sense of community and belonging.

3. Dynamic Visual Engagement

Platforms such as Instagram and TikTok allow libraries to engage in dynamic visual storytelling. This can include highlighting new acquisitions, providing a glimpse into library operations, or presenting book recommendations in imaginative ways. These platforms also enable libraries to attract younger audiences through trends, challenges, and interactive content, making social media outreach more vibrant and appealing.

4. Collaboration and Advocacy

Social media serves as a valuable tool for libraries to advocate and collaborate. By partnering with local organizations and utilizing their platforms, libraries can promote significant initiatives, such as literacy programs, open access to information, and community education efforts. Joint online campaigns can enhance awareness and strengthen community ties.

CONCLUSION

Social media serves as a significant asset for library outreach, enabling connections with communities, showcasing services, and broadening the library's influence beyond its physical location. Despite ongoing challenges like content management and the digital divide, the potential of social media platforms for immediate interaction, virtual offerings, and fostering community is substantial. As libraries evolve in the digital era, social media will be an essential component of their outreach efforts, helping to maintain their relevance, accessibility, and inclusivity for everyone.

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Recent Educational Policies: Trends, Impacts and Challenges

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ABSTRACT

This paper examines recent educational policies, highlighting emerging trends, their impacts on various stakeholders, and the challenges they present. In the context of a rapidly evolving global landscape, policies have increasingly focused on inclusivity, digital literacy, and equitable access to resources. We analyze how these policies have influenced student outcomes, teacher effectiveness, and community engagement, employing both quantitative and qualitative data. The findings indicate a mixed impact; while some initiatives have led to significant improvements in educational equity and engagement, others have faced resistance due to insufficient funding, inadequate training, and varying regional needs. Challenges such as the digital divide, socio-economic disparities, and the need for adaptive curricula are discussed in detail. This study underscores the necessity for ongoing evaluation and collaboration among policymakers, educators, and communities to effectively address these challenges and enhance the educational landscape.

Keywords: Educational Policy, Digital literacy, Trends, Impact, Communities.

INTRODUCTION

In recent years, the landscape of education has undergone significant transformation driven by a myriad of factors, including technological advancements, globalization, and shifting societal needs. Educational policies, as frameworks guiding these transformations, have evolved to address emerging challenges while promoting equitable access to quality education. This introduction explores recent trends in educational policies, their impacts on various



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stakeholders, and the challenges that continue to shape the educational environment **National Statistical Office.** (2021).

Trends in Educational Policies

One of the most notable trends in recent educational policies is the emphasis on inclusivity and equity. Policymakers are increasingly recognizing that diverse learning needs must be met to ensure all students can thrive. Initiatives aimed at closing achievement gaps among marginalized groups have gained momentum, with a focus on enhancing support for underrepresented students, including those from low-income backgrounds and minority communities. For example, many countries have adopted policies to provide additional funding for schools in disadvantaged areas, fostering a more equitable distribution of resources **Nayak, S.** (2021). Additionally, the integration of technology into education has been a pivotal trend. The COVID-19 pandemic accelerated the adoption of digital learning platforms, prompting policymakers to rethink traditional teaching methodologies **Suresh, K.** (2020). Many educational systems have implemented policies promoting digital literacy and the use of online resources to ensure students can navigate an increasingly digital world. However, the implementation of these technologies raises questions about accessibility and the potential widening of the digital divide, especially for students in rural or underserved communities **Bansal, R.** (2021). Another significant trend is the push for competency-based education. This approach shifts the focus from traditional seat-time requirements to a model that emphasizes mastery of skills and knowledge. By allowing students to progress at their own pace, competency-based policies aim to foster a more personalized learning experience. This shift has prompted discussions about assessment methods, curriculum design, and the role of educators in facilitating individualized learning paths.

Impacts of Educational Policies

The impacts of these trends in educational policies are multifaceted, affecting students, educators, and communities. On the student level, policies promoting inclusivity and equity have led to improved educational outcomes for many. For instance, targeted interventions and support systems have been shown to enhance engagement and achievement among historically underserved populations. Furthermore, the emphasis on digital literacy prepares students for future job markets, equipping them with essential skills for success in an increasingly technological society **NITI Aayog** (2021). Educators, too, have felt the effects of recent policy changes. Professional development initiatives aimed at enhancing teachers' competencies in inclusive teaching practices and technology integration have emerged as crucial components of successful educational reforms. However, the rapid pace of policy changes can lead to stress and burnout among educators, particularly if sufficient support and resources are not provided. As teachers adapt to new methodologies and expectations, ongoing training and collaborative opportunities become essential to maintaining morale and effectiveness. Communities also play a vital role in the implementation and impact of educational policies. Strong partnerships between schools, families, and local organizations can enhance the effectiveness of initiatives aimed at improving educational access and quality. However, disparities in community resources and engagement levels can create challenges. Policymakers must consider these factors to ensure that reforms are not only implemented but also sustainable and effective in the long term **Kumar, A.** (2021).

Challenges Ahead

Despite the positive trends and impacts associated with recent educational policies, several challenges persist. One of the most pressing issues is the digital divide. While technology has the potential to enhance learning experiences, not all students have equal access to devices and reliable internet. This gap can exacerbate existing inequities, hindering the educational progress of vulnerable populations. Policymakers must prioritize solutions that bridge this divide, ensuring all students can benefit from technological advancements. Additionally, the sustainability of new initiatives poses another challenge. Many educational reforms require significant financial investment, and budget constraints can limit their implementation and effectiveness. Policymakers must develop strategies to secure funding while also ensuring that resources are allocated equitably across different regions and demographics. Lastly, the need for ongoing evaluation and adaptation of educational policies cannot be overstated. As societal needs evolve, so too must the frameworks that govern education. Continuous feedback from educators, students, and communities is essential for refining policies and ensuring they remain relevant and effective.



**Sudheer Choudari and Madhava Rao****Recent Trends in Educational Policies****Digital Learning and Technology Integration**

In response to the pandemic, many countries accelerated the integration of technology in education. Policies promoting digital literacy, remote learning infrastructure, and access to online resources have become paramount. For instance, the U.S. introduced initiatives to provide internet access to underserved communities, ensuring that all students can participate in online learning.

Focus on Equity and Inclusion

Recent policies have increasingly emphasized equity in education. Governments have implemented strategies to support marginalized groups, including students with disabilities, ethnic minorities, and low-income families. For example, the UK's "Inclusive Education Strategy" aims to remove barriers and create supportive environments for all learners.

Skills-Based Education

As the job market evolves, there is a growing emphasis on skills-based education. Policies encouraging vocational training, apprenticeships, and STEM (Science, Technology, Engineering, and Mathematics) education have gained traction. Countries like Germany have reinforced their dual education system, blending classroom learning with practical experience in the workforce.

Mental Health and Wellbeing

Recognizing the importance of mental health, many educational policies now include provisions for student wellbeing. Schools are increasingly required to implement programs that promote mental health awareness and provide support services. The Australian government, for instance, has invested in initiatives that enhance mental health resources in schools.

Impacts of Educational Policies**Positive Outcomes**

Increased Access: Initiatives aimed at improving digital access have led to greater participation in online learning, particularly among disadvantaged groups. Enhanced Skills Development: Skills-based education policies have resulted in a more competent workforce, better prepared for current job demands. Greater Inclusivity: Efforts to support marginalized groups have improved educational outcomes and increased representation in higher education.

Challenges

Digital Divide: Despite efforts to enhance digital access, disparities remain, particularly in rural areas, limiting the effectiveness of remote learning initiatives. Implementation Gaps: Policies often face challenges during implementation due to lack of training for educators and insufficient resources. Mental Health Stigma: Although mental health initiatives are growing, stigma and insufficient funding can hinder their effectiveness in schools.

Case Studies

United States: Every Student Succeeds Act (ESSA)

ESSA emphasizes state responsibility for education quality while fostering flexibility and innovation. The act aims to close achievement gaps and ensure that all students have access to high-quality education. Initial evaluations indicate improvements in standardized test scores and graduation rates, though disparities remain.

Finland: Education Reform for Inclusivity

Finland's educational policies focus on inclusivity and student-centered learning. Recent reforms have enhanced teacher training and integrated support for students with diverse needs. Finland consistently ranks high in educational outcomes, demonstrating the effectiveness of its approach.

National Education Policy (NEP 2020)

The National Education Policy (NEP) 2020 in India marks a significant shift in the country's educational landscape, aiming to transform the education system to make it more holistic, flexible, multidisciplinary, aligned to the needs of the 21st century, and aimed at bringing out the unique capabilities of each student. Here are the key highlights of the NEP 2020:



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- **New Curricular Structure:** Introduction of the National Educational Policy for school education, replacing the existing 10+2 structure with a new curricular structure known as the National Education Policy, or the 5+3+3+4 system. This framework covers the foundational stage (ages 3-8), the preparatory stage (ages 8-11), the middle stage (ages 11-14), and the secondary stage (ages 14-18).
- **Early Childhood Care and Education (ECCE):** Emphasis on the importance of ECCE, recognizing it as crucial for children's development.
- **Holistic Assessment:** Shift from rote learning to a more comprehensive approach, emphasizing formative assessment and critical thinking.

Higher Education

- **Multidisciplinary Education:** Introduction of a multidisciplinary approach at the higher education level, allowing students to choose subjects from various disciplines.
- **Higher Education Commission of India (HECI):** Establishment of a new umbrella body to oversee higher education institutions and promote quality and innovation.
- **National Higher Education Qualification Framework (NHEQF):** Implementation to ensure that degrees reflect the competencies achieved by students.

Teacher Education and Training

- **National Educational Technology Forum (NETF):** A platform for teachers and educators to share experiences, tools, and strategies to enhance teaching.
- **Continuous Professional Development:** Emphasis on continuous training and professional development for teachers, with the aim of improving teaching quality.

Focus on Technology and Innovation

- **Integration of Technology:** Increased emphasis on the use of technology in education, including online learning platforms and digital resources.
- **Digital Infrastructure:** Enhancement of digital infrastructure in schools and colleges to facilitate e-learning and digital literacy.

Equity and Inclusion

- **Access for Marginalized Groups:** Policies aimed at ensuring education access for underrepresented and marginalized groups, including economically disadvantaged, SC/ST, and girls.
- **Vocational Education:** Introduction of vocational education at all levels of education, with an emphasis on skill development and employability.

Financial Support

- **Increased Budget Allocation:** A call for raising the public investment in education to 6% of GDP to ensure comprehensive development and sustainability of educational initiatives.

National Assessment Centre (SATHI)

- **Quality Assessment:** Establishment of a national assessment center to evaluate the quality of education and learning outcomes.

CONCLUSION

Recent educational policies reflect a global commitment to improving educational systems in response to contemporary challenges. While there have been significant advancements in access, inclusivity, and skills



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development, ongoing challenges remain. Policymakers must continue to adapt and innovate to ensure that all students receive a quality education that prepares them for the future.

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Assessment of Water Requirement and its Prediction Using FAO-CROPWAT Model-8.0 for Sunflower Crop to Vizianagaram District, A.P.

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ABSTRACT

The water requirement differs from crop to crop and is economically important to understand the water use efficiency for better productivity. Water requirement for Sunflower (*Helianthus annuus L.*) is relatively high in comparison to other oil crops and soil water deficit at certain sensitive growth stages leads to substantial reduction in seed yield. In this direction, the present study demonstrates the sunflower crop irrigation and water requirement prediction by using the FAO-CROPWAT Model-8.0. Crop irrigation schedule provides an overall Evapotranspiration (ET_c) value of 362.5 millimeters as the optimal water requirement for achieving maximum crop production with sufficient water supply. The actual water utilization by the crop during its growth period amounted to 360.7 millimeters and total net irrigation applied was 184.5 millimeters, while the gross irrigation amounted to 263.6 millimeters. The irrigation efficiency was 100%. Comparing this approach to irrigation scheduling based on the Irrigation Water to Crop Potential Evapotranspiration (IW/CPE) ratio, using CROPWAT enabled the precise management of irrigation water. The measures taken ensured that the sunflower crop received the precise amount of water in accordance with its distinct growth stage needs. The study demonstrated no reduction in yield, even when the available soil moisture reached a critical depletion level of 100%. Thus, the present study encourages the researchers to inculcate the concept of predicting crop water requirement to schedule the irrigation for sunflower crop. Further, the study can be a model to predict crop water requirement and its usage in other crops as well.



Chandaka Deepthi *et al.*,**Keywords:** Crop water requirement, Irrigation schedule, Sunflower, CROPWAT

INTRODUCTION

Water is pivotal and indispensable role in agriculture and the call for the effective utilization of irrigation water in crop cultivation is growing in response to shifting climatic conditions. In India, agriculture stands as the primary consumer of water resources among all sectors approximately 70% of total withdrawals of freshwater resources. Significant endeavors are necessary to ensure its efficient and responsible utilization (Surendran *et al.*, 2015). Under the changing climatic conditions, the availability of irrigation water is diminishing on a daily basis and the necessity for sustainable and proficient water administration in agriculture. It becomes more crucial to schedule and plan the irrigation with predicted information prior to execute the agricultural activities in the field with respect to the crop to be cultivated. As the changing climatic conditions demands robust crops which are commercially important, tolerant to adverse conditions leading to high productivity, the usage of certain databases and its applications on agricultural activities becomes essential. In this direction, a software tool CROPWAT 8.0 developed by Food and Agriculture Organization of the United Nations (FAO) to help agricultural professionals, researchers and farmers (Salam *et al.*, 2019) to calculate and manage the water requirements of various crops including rice, maize, sunflower, etc., can be used to predict parameters such as rainfall, weather conditions and evapotranspiration rate, which further estimate the water balance, crop water requirement and need of irrigation. Crop water requirement depends on the climatic conditions, crop area, crop type, soil type, growing seasons and crop production frequencies (FAO, 2009 & George *et al.*, 2000). Crop Coefficient (K_c) and potential evapotranspiration value (ET_0) plays a major role in determining value of the crop water requirement, irrigation scheduling along with different cropping patterns for both rainfed and irrigated conditions (Kuo *et al.*, 2006; Gowda *et al.*, 2013; Gouranga & Verma, 2005; Martyniak *et al.*, 2006; Dechmi *et al.*, 2003 & Zhiming *et al.*, 2007) based on the crop cultivated, location, soil-types and agro-economic conditions (Solomon *et al.*, 2018, Roja *et al.*, 2020).

Reduction in water limits the evapotranspiration (ET) through stomata closure, reduced assimilation of carbon and decreased biomass production (Demir *et al.*, 2006). Water requirement is dependent on several factors like crop type, its growth stage, climatic conditions, type of the soil and water availability. In the present study, the data generated by using CROPWAT 8.0 software program on sunflower and its growth based on the water requirement. It is important to note that water requirement for Sunflower (*Helianthus annuus L.*) is relatively high in comparison to other oil crops and soil water deficit at certain sensitive growth stages leads to substantial reduction in seed yield (Beyazgulet *et al.*, 2000). Sunflower (*Helianthus annuus L.*) holds a prominent position as one of the world's top four essential oil seed crops (David Oscar Yawson *et al.*, 2011). Thus, obtaining accurate scientific data on crop water requirement is essential to optimize irrigation schedule, water balancing, canal design capacities determination, regional drainage management, water resources and its management for sunflower crop.

MATERIALS AND METHODS

Weather Data

A pooled weather data of 10 years was collected from the meteorological station, Naira located at Srikakulam district used in the calculations and climatic characteristics are shown in table 1. The station is positioned at a latitude of 18.38°N, a longitude of 83.90°E and an altitude of 9 meters above sea level. Meteorological parameters used for computing ET_0 (Reference evapotranspiration) are latitude, longitude and altitude, as well as maximum and minimum temperature (°C), humidity (%), wind speed (km/day), rainfall and sunshine hours. ET_0 was calculated for every ten days (defined as 'decade' by FAO) and then cumulated to monthly data. Soil characteristics considered for estimation of crop water requirement are available water content (mm/m) and depth of soil (cm).



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Crop Water Requirement

The crop water requirement (CWR) is the quantity of water needed to compensate for the water lost from a cultivated field due to evapotranspiration (ET), expressed as a daily rate in millimeters. The estimation of CWR is based on crop evapotranspiration (ET_c), which can be calculated using the following formula:

$$ET_c = K_c \times ET_0$$

Here's a breakdown of the key terms and concepts:

ET_c (Crop Evapotranspiration): This represents the water loss from the crop.

K_c (Crop Coefficient): K_c is a ratio that compares the crop's ET_c to the reference evapotranspiration (ET₀). It encompasses several factors that distinguish the crop from reference grass, including the crop's albedo (reflectance of the crop-soil surface), crop height, canopy resistance and soil evaporation.

Crop Growth Stages: The crop coefficient (K_c) varies during the crop's growth stages. It is typically divided into four distinct stages: initial, crop development, mid-season and late season. Each stage has a different K_c value to account for the changing water needs of the crop.

Reference Evapotranspiration (ET₀): ET₀ is calculated using the FAO Penman-Monteith method. This method considers meteorological data and other parameters to estimate the potential evapotranspiration for a reference crop (typically grass) under standard conditions.

Crop Data

Major crops grown in this region are rice, black gram, green gram, horsegram, groundnut, sugarcane, sesame, sunflower, pearl millet, mesta and finger millet etc. CROPWAT Model requires the crop data like, crop coefficient, K_c values (initial, mid and late growth stages), rooting depth (table 2), length of plant growth stages, critical depletion and yield response factor which were taken from FAO Irrigation and drainage paper 56. Crop coefficient values (K_c) are taken from available published data. K_c values for initial, mid and late growth stages of annual and seasonal crops are used. In the case of perennial crops, same K_c value is used for the whole year. Sowing and harvesting date were taken according to the guide from agricultural operations over this area.

Soil data

The type of soil in this area is a red sandy loam soil (table 3). The software needs some general soil data like total available soil moisture, maximum rain infiltration rate, maximum rooting depth, initial soil moisture depletion and initial available soil moisture. The information obtained from FAO manual 56.

Irrigation schedule

Irrigation scheduling is a crucial process that entails determining the precise amount of water required for irrigation and the optimal timing for its application. The CROPWAT 8.0 model plays a pivotal role in this process by calculating three key parameters: reference evapotranspiration (ET₀), crop water requirement and irrigation requirements. These calculations are instrumental in formulating irrigation schedules, taking into account varying management conditions and water supply plans.

RESULTS AND DISCUSSION

The information about weather related parameters like minimum-maximum temperature, humidity, rainfall and sunshine hours collected from Naira meteorological research station, Srikakulam, Andhra Pradesh, was analyzed for sunflower crop water requirement including reference evapotranspiration (ET₀), effective rainfall and total irrigation requirement for sunflower using CROPWAT 8.0 software program. The crop water requirement predictions at daily, monthly and decadal was generated based on a threshold critical soil moisture depletion of 80 % for different growth stages of sunflower crop. Accordingly, the sunflower crop showed the crop water requirement with 362.5 mm whereas, the irrigation requirement was 270.3 mm (Table 5, Fig.3), without affecting the actual seed yield. The result provided a valuable insight into the required water for sunflower crop supporting the recommended plan of irrigation and its management. The score for total gross irrigation, total net irrigation, actual water use and potential



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water use in sunflower is been illustrated in the Table 4. A well-predicted irrigation schedule for sunflower was generated and is enlisted in the Table 6, with three distinct time in December, January and February. The total available soil moisture (TAM) signifies the water reservoir accessible to the crop sunflower. On the other hand, readily available soil moisture (RAM) indicates readily available water which is a part of TAM, from which the plant absorbs from the root zone without experiencing the water stress (Fig.4). The prediction depicts that there will be no yield reduction at different growth stages. Likewise, the maximum rainfall efficiency is expected to contribute to the optimal sunflower growth and yield. Thus, the data directs significantly towards irrigation management practices for sunflower ensuring an efficient water utilization with the predicted crop productivity.

Irrigation Requirement

Irrigation was performed under two extreme conditions one is at 100% critical depletion conditions and another under the replenishing soil moisture to field capacity. The analysis revealed a rainfall efficiency of 39.4%, resulting in a total effective rainfall of 84.9 mm. Notably, the total net irrigation requirements were affected by variations in effective rainfall efficiency. Due to high temperatures, the evapotranspiration rates in sunflower were increased significantly with increased number of irrigation schedules, indicating the requirement of water. In addition, crop shifting from one season to another (sunflower to cluster bean) was planned to record the changes in crop's production periods thereby, to understand the effect on crop water requirement. These findings highlighted the dynamic nature of crop water management, emphasizing the need for adaptive irrigation strategies that account for factors such as weather conditions and planting schedules to optimize water use and crop yields.

Net irrigation requirement (NIR)

A valuable insight about the daily and decadal crop water requirements for sunflower grown during rabi under the climatic conditions of north coastal zone, Andhra Pradesh (AP) state, India. Interestingly, the highest demand for water in sunflower cultivation occurs during the late season phase (January), where it reaches 42.3 mm. In contrast, the lowest water requirement is observed during the initial growth phase (June). This difference can be attributed to the study reported on the different crops which exhibit relatively lower metabolic activity during the early stages of growth, while their water demands increase significantly during the rapid growth phase (Abirdewet *et al.*, 2018; Roja *et al.*, 2020). The CROPWAT 8.0 model in the present study estimated the total crop water requirement for sunflower as mentioned above. To determine the actual irrigation requirement, the model considered the impact of actual rainfall as a portion of the water requirement. Further, the net irrigation requirement for sunflower was calculated to be 184.5 mm, while the gross irrigation requirement was higher at 263.6 mm.

Irrigation Scheduling

In the context of irrigation scheduling for sunflower, where red sandy loam soils predominate, the recommended approach involves irrigation at 50% of critical depletion. This irrigation practice ensures that the soil is replenished to 100% of its field capacity. A report by Yawson, *et al* (2011), depicted that during the growing period, sunflower typically requires 5-6 irrigation sessions. The model predicted the two sessions of irrigation for an effective rainfall during December and January months.

CONCLUSION

A comprehensive effort has been undertaken to calculate the crop water requirements for sunflower cultivation in the North coastal districts of Andhra Pradesh using the CROPWAT 8.0 model developed by FAO. Based on the regular and inadequate rainfall pattern, the software model demonstrated the importance of effective water resource management. In light of these results, it is strongly advocated to employ the CROPWAT 8.0 model as a dependable tool for precisely forecasting the water requirements of various crops. By adhering to the recommendations generated by the CROPWAT 8.0 model, the agricultural practitioners can promote their agricultural output in addition to the contribution towards conservation of water resources which helps the farmers in promoting





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sustainable practices. Thus, such studies address the mounting challenges associated with water scarcity and ensures the security of future food supplies.

Conflicts of Interest

The author (s) has declared that no conflict is involved in this article's publication.

Table 1: Details of crop from planting to harvest as per CROPWAT 8.0 model:

(Critical depletion & rooting depth- helps to determine when and how much irrigation is needed for a particular crop), Initial Stage (germination to leaves growth), Development Stage (vegetative phase), Mid stage (reproductive stage) & late stage (crop reaches maturity and the dibble parts are fully developed for harvest).

Table 6: Irrigation schedules for sunflower crop during the study period as per the CROPWAT model:

CROPWAT Model scheduled irrigation at middle stages of crop as it is a reproductive stage it requires more water for further development of crop seed from vegetative phase. When actual Evapotranspiration is 100 % and depletion is 50% the net irrigation required for crop is 91.7 mm at 72 DAS (Days after sowing) whereas, when depletion is 51 % the net irrigation requirement by crop is 92.8 mm at 99 DAS.

Table 7: Yield reduction at critical depletion by CROPWAT 8.0 Model: The table represents the yield reduction at critical depletion for estimating crop water requirement and effects A, B, C & D represents stages of the crop (initial, development, middle & late), for estimating crop water requirements and the effect of water stress on crop yield.

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Table 1: Average meteorological data, ER & ET₀ of Naira area (average for 2012–2022 period) obtained using CROPWAT software

	Month	T Max.(°C)	T Min.(°C)	Mean RH (%)	Wind (km/day)	Mean bright sunshine hours	Rain (mm)	ER (mm)	Rad (MJ/m ² / day)	ET ₀ (mm/day)
1	January	27.7	16.2	71	154	8.6	12.0	11.8	17.8	3.43
2	February	31.4	18.3	62	180	8.8	8.0	7.9	19.8	4.58
3	March	35.7	22.1	56	211	9.2	10.0	9.8	22.3	6.12
4	April	36.9	24.0	57	237	8.8	19.0	18.4	22.9	6.74
5	May	36.8	26.5	63	248	8.3	34.0	32.2	22.3	6.61





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6	June	32.6	25.7	75	244	6.8	117.0	95.1	19.9	5.21
7	July	30.1	24.4	84	222	5.8	168.0	122.8	18.5	4.15
8	August	29.6	24.2	86	175	5.9	159.0	118.6	18.5	3.93
9	September	28.5	24.0	87	166	6.3	170.0	123.8	18.3	3.76
10	October	27.0	22.3	84	175	7.0	247.0	149.4	17.8	3.50
11	November	29.2	18.9	82	187	8.0	69.0	61.4	17.3	3.51
12	December	25.8	16.1	77	177	8.5	11.0	10.8	17.0	3.15
Average		30.9	21.9	74	205	7.6	24.0	761.9	19.4	4.56

Table 2: T= Temperature, Min. = Minimum, Max. = Maximum, RH = Relative Humidity, ER = Effective Rainfall, Rad. = Radiation, ET₀ = Evapotranspiration

Table 3: Details of crop from planting to harvest as per CROPWAT 8.0 model:

Crop name	Planting date	Harvesting date	Critical depletion	Rooting depth	Crop growth period (DAS- Days after Sowing)				
					Initial	Development	Mid	Late	Total
Sunflower	15 th oct.	21 st feb.	0.58	0.8	25	35	45	25	130

Table 4: Soil data details as per FAO manual in CROPWAT 8.0 model

Soil	Red sandy loamy	
Total available soil moisture (FC-WP)	140.0	mm/meter
Maximum rain infiltration rate	30	mm/day
Maximum rooting depth	900	Centimeters
Initial soil moisture depletion (as % TAM)	0	%
Initial available soil moisture	140.0	mm/meter

(FC = Field capacity, WP = wilting point, TAM = Total available soil moisture)

Table 4: Total gross, net irrigation and rain efficiency illustrated in table given below based on CROPWAT 8.0 model

Gross irrigation	263.6 mm	Total rainfall	215.4 mm
Total net irrigation	184.5 mm	Effective rainfall	84.9 mm
Total irrigation losses	0.0 mm	Total rain loss	130.5 mm
Actual water use by the crop	360.7 mm	Moist deficit at harvest	91.3 mm
Potential water use by the crop	360.7 mm	Actual irrigation requirement	275.8 mm
Efficiency irrigation schedule	100.0 %	Efficiency rain	39.4 %
Deficiency irrigation schedule	0.0 %		

Table 5: Daily and Decadal Crop Water Requirement of sunflower in the study area according to CROPWAT Model

Month	Decade	Stage	Kc (coeff)	ETc (mm/day)	ETc (mm/dec)	Eff. Rain (mm/dec)	Irr. Req. (mm/dec)
October	2	Init	0.35	1.27	7.6	33.1	0.0
October	3	Init	0.35	1.23	13.6	43.6	0.0
November	1	Deve	0.36	1.22	12.2	29.1	0.0
November	2	Deve	0.52	1.72	17.2	18.7	0.0
November	3	Deve	0.74	2.40	24.0	13.7	10.4
December	1	Deve	0.96	3.06	30.6	7.6	23.0
December	2	Mid	1.12	3.50	35.0	1.2	33.8



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December	3	Mid	1.12	3.63	40.0	2.1	37.9
January	1	Mid	1.12	3.74	37.4	3.9	33.5
January	2	Mid	1.12	3.86	38.6	4.1	34.4
January	3	Late	1.10	4.18	45.9	3.6	42.3
February	1	Late	0.83	3.48	34.8	2.9	31.9
February	2	Late	0.52	2.38	23.8	2.4	21.4
February	3	Late	0.35	1.78	1.8	0.3	1.8
					362.5	166.4	270.3

Init. = Initial, Deve = Development, Mid = middle stage (reproductive), Kc – Crop Coefficient, ETc – Crop Evapotranspiration, Eff. Rain – Effective Rainfall, Irr. Req. – Irrigation Requirement

Table 6: Irrigation schedules for sunflower crop during the study period as per the CROPWAT model:

Date	Day	Stage	Rain (mm)	Ks (fract.)	Eta (%)	Depl (%)	Net irr (mm)	Deficit (mm)	Loss (mm)	Gross irrigation (mm)	Flow (mm)
25 Dec	72	Mid	0.0	1.0	100	50	91.7	0.0	0.0	131.1	0.21
21 Jan	99	Mid	0.0	1.0	100	51	92.8	0.0	0.0	132.5	0.57
21 Feb	End	End	0.0	1.0	0	50					

Ks = Water stress coefficient, Eta = Actual Evapotranspiration, Depl = Depletion, Net irri = Net Irrigation

Table 7: Yield reduction at critical depletion by CROPWAT 8.0 Model:

Stage label	A	B	C	D	Season (%)
Reductions in ETc	0.0	0.0	0.0	0.0	0.0
Yield response factor	0.40	0.60	0.80	0.80	0.95
Yield reduction	0.0	0.0	0.0	0.0	
Cumulative yield reduction	0.0	0.0	0.0	0.0	0.0

Table 8: Cropping scheme for sunflower crop during the study period as per the CROPWAT model

	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit												
Sunflower	110.2	55.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	10.4	94.7
Net scheme irr.req.												
In mm/day	3.6	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	3.1
In mm/month	110.2	55.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	94.7
In l/s/h	0.41	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.35
Irrigated area (% of total)	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Irr.req. for actual (l/s/h)	0.41	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.04	0.35



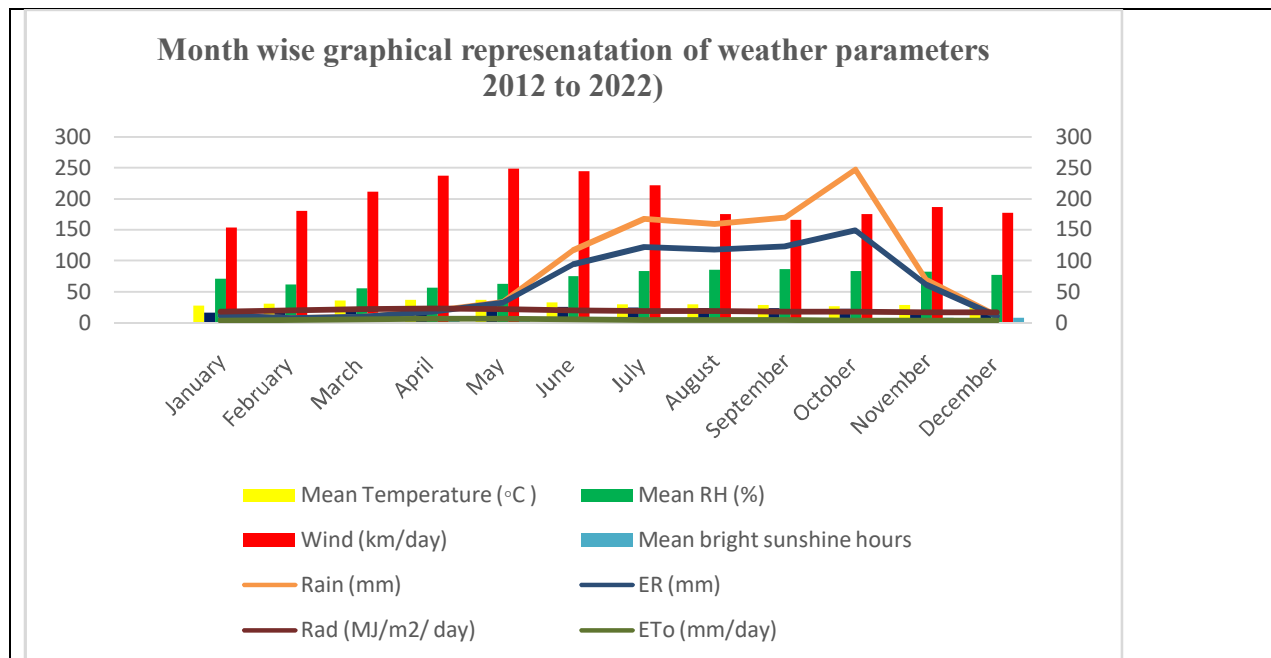
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Figure 1: Graph depicting weather parameters like temperature (helps to maintain yield), RH- Relative Humidity (helps to maintain photosynthetic process and minimize evaporation process of plants), Wind (increases turbulence in atmosphere, thus increasing the supply of CO₂ to the plants resulting in the greater photosynthesis), Sunshine hours (helps to understand its distribution and its effect on crop production), Rad. – Radiation (helps in measuring water content of crops for crop water requirement determination), ETo – Reference Evapotranspiration & ER – Effective Rainfall (indicates how much amount of water crop used for its growth and development)

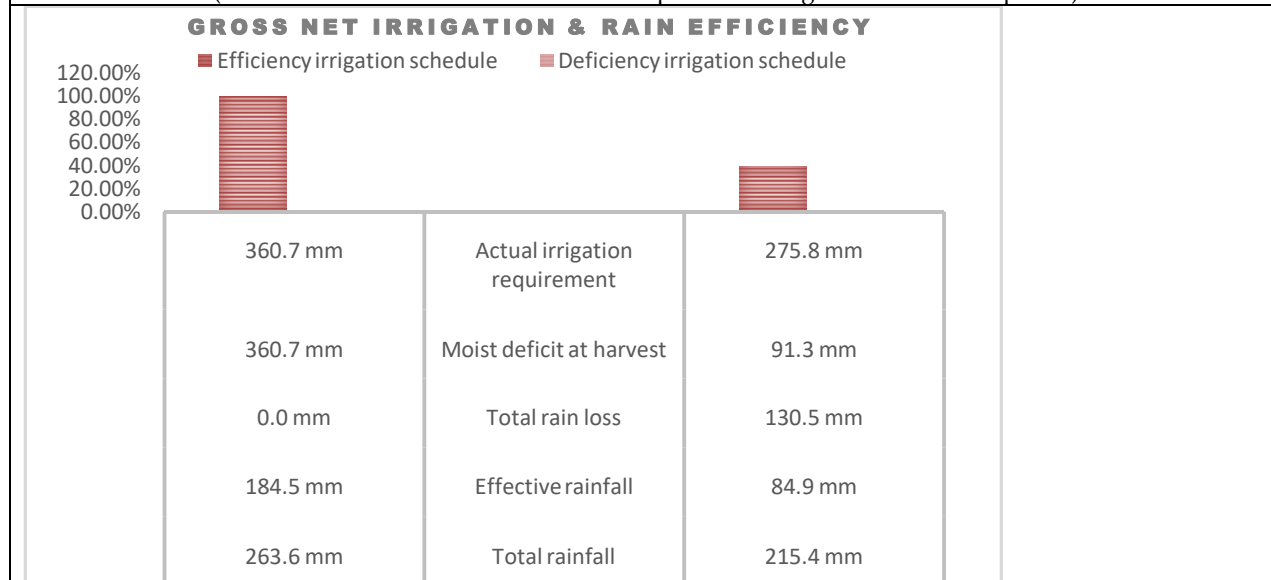


Figure 2: Graph representing gross, net irrigation and rain efficiency (graph shows total rainfall of (215.4mm) among that rainfall crop used only 84.9 mm efficiently whereas, remaining water is lost due to several factors like leaching, floods and may be due to improper distribution of rainfall). When irrigation is scheduled at 100 % the gross & net irrigation required by crop is 263.6 & 184.5 mm.





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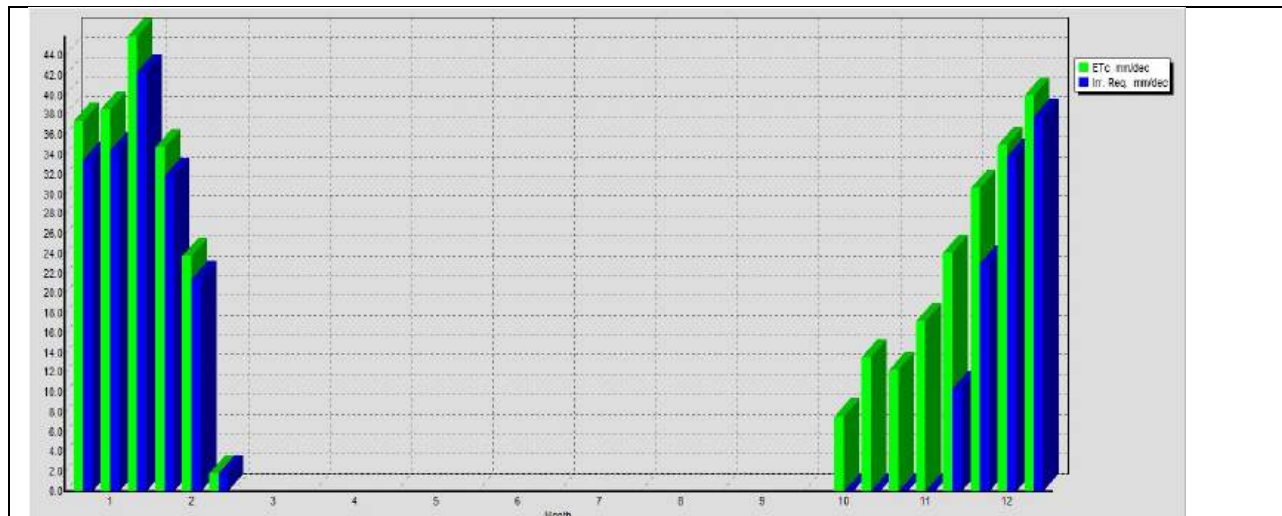


Fig 3: Crop water requirement for sunflower crop (The graph indicates Crop water requirement of sunflower crop where, green color indicates Crop Evapo transpiration (ETc) & blue color is indicates irrigation Requirement (Irr. Req). Requirement of both ETc&Irr. Req. are less at initial stages of crop (7.6 & 0.0 mm/dec) in October month whereas, highest in January month (45.9& 42.3 mm/dec) at late stage and its requirement is very very less at maturity stage (1.8 mm/dec).

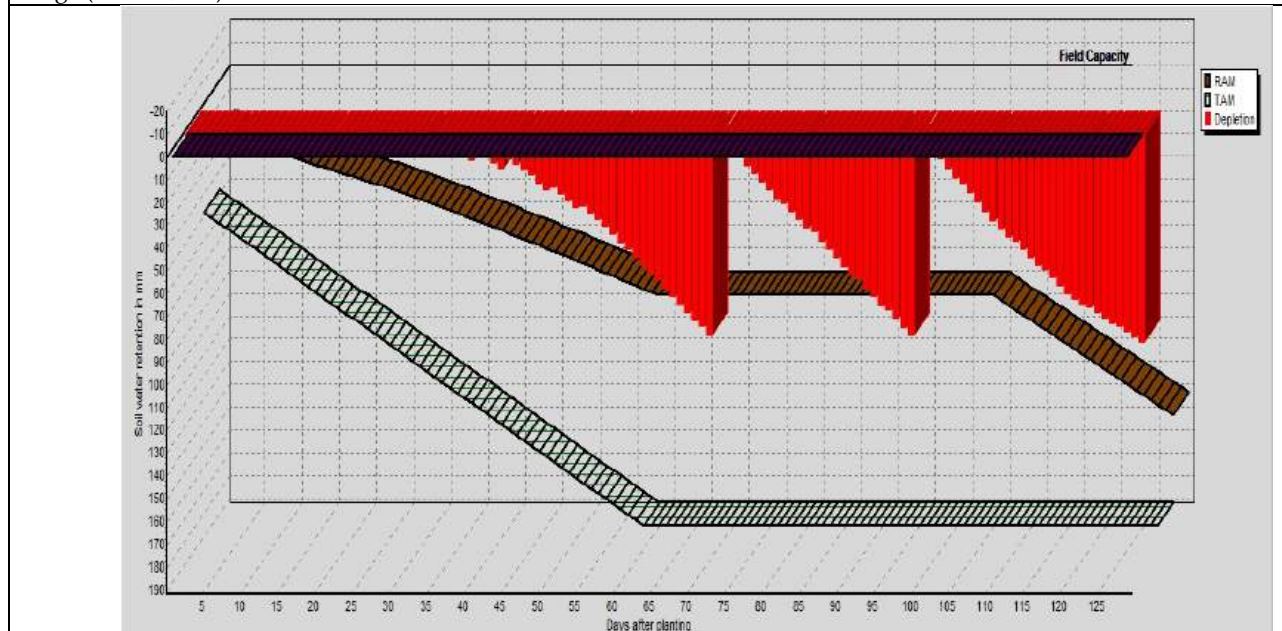


Figure 4.CROPWAT 8.0 model suggested irrigation scheduling graph showing total available soil moisture (TAM), readily available soil moisture (RAM), water depletion and field capacity. At initial stages of crop depletion is less due to readily available soil moisture more.





Importance of Industrial Automation: a Comparative Analysis of Production Volume vs. Cost of Production

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ABSTRACT

Industrial automation is transforming the manufacturing landscape by integrating advanced technologies like robotics, artificial intelligence (AI), and the Internet of Things (IoT). This evolution enhances operational efficiency, enabling companies to increase production rates and reduce errors while addressing growing competitive pressures. Despite the significant initial investment, the long-term benefits, including improved production volume and cost efficiency, often outweigh the costs. This article examines the implications of automation on manufacturing processes, emphasizing its role in sustainability and productivity. Utilizing a mixed-methods approach, qualitative insights from industry experts complement quantitative data from various sectors, highlighting automation's impact on key performance indicators. Case studies from the automotive, electronics, and food production industries illustrate substantial gains in output and quality, showcasing the necessity for organizations to adopt automation strategies. However, challenges such as job displacement, integration complexities, and cyber security risks remain significant. As manufacturing trends evolve towards smart technologies, the strategic adoption of automation will be crucial for organizations aiming to thrive in a rapidly changing marketplace.

Keywords: Industrial Automation, Robotics, Artificial Intelligence, Production Volume, Industry 4.0



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INTRODUCTION

Industrial automation fundamentally alters the landscape of manufacturing, driven by the integration of advanced technologies such as robotics and artificial intelligence. This evolution enhances operational efficiency, allowing companies to increase production rates while minimizing errors [1]. As global competition heightens, the pressure to optimize costs and streamline processes intensifies [2]. Automation enables manufacturers to respond swiftly to changing market demands, ensuring consistent product quality and reducing waste [3]. However, the significant initial investment required raises important considerations regarding return on investment and strategic planning [4]. This article will explore the implications of automation on production volume and cost structures, highlighting its essential role in modern manufacturing. Industrial automation signifies a paradigm shift in manufacturing processes, driven by the integration of cutting-edge technologies such as robotics, artificial intelligence (AI), and the Internet of Things (IoT). This shift not only streamlines operations but also enhances efficiency, enabling companies to achieve higher production volumes while maintaining quality standards. The competitive landscape is increasingly influenced by these advancements, as firms that effectively leverage automation can respond more rapidly to market demands, adapt to changing consumer preferences, and minimize production costs. Furthermore, automation facilitates continuous operations, significantly reducing downtime typically associated with human labor. However, the initial capital investment required for automated systems raises concerns about return on investment (ROI) and financial feasibility, particularly for small and medium enterprises. As industries strive for operational excellence, understanding the balance between production volume and cost becomes critical. This article aims to explore the intricate relationship between industrial automation, production volume, and cost structures, highlighting the strategic importance of automation in fostering sustainability, enhancing productivity, and ultimately ensuring the long-term viability of manufacturing businesses in an increasingly competitive global marketplace.

LITERATURE REVIEW

The evolution of industrial automation has been extensively documented, revealing shifts from basic mechanization to sophisticated automated systems. Early studies emphasized the operational efficiency gained through the introduction of simple technologies [5], but recent research highlights the transformative impact of advanced robotics, artificial intelligence, and data analytics [6]. Scholars have identified clear correlations between automation and enhanced productivity, with findings supporting significant reductions in error rates and production costs [7]. Additionally, literature emphasizes the role of automation in sustainable manufacturing practices [8]. As industry standards evolve, the importance of adapting to technological advancements and incorporating data-driven decision-making becomes increasingly apparent in manufacturing contexts [9]. The evolution of industrial automation has been a subject of extensive scholarly research, highlighting the transition from traditional manufacturing methods to modern automated systems. Initially focused on mechanization, early studies underscored the benefits of introducing basic technologies to enhance productivity and reduce manual labor [5]. However, the rapid advancements in robotics, AI, and data analytics have shifted the narrative, demonstrating their profound impact on efficiency, precision, and overall productivity. Recent literature emphasizes the significant correlation between automation and increased production capacity, with studies showing that companies can achieve substantial cost reductions and error minimization through automation [7]. Additionally, the integration of Industry 4.0 principles has redefined manufacturing paradigms, emphasizing smart technologies and connectivity [5]. This literature also highlights the importance of adapting to these technological advancements, as organizations must evolve their strategies to incorporate data-driven decision-making and flexible manufacturing processes [9]. As industries face increasing pressures to remain competitive, the insights gleaned from previous research underscore the necessity for continuous innovation and the adoption of advanced automation technologies to sustain growth and meet evolving market demands.





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METHODOLOGY

This study employs a mixed-methods approach, combining qualitative and quantitative research to analyze the impact of industrial automation on production metrics. Qualitative data were gathered through interviews and surveys with industry experts to understand firsthand experiences and challenges in implementing automation [10]. This was supplemented by quantitative data from diverse sectors, including automotive and electronics, focusing on key performance indicators such as production volume and cost efficiency [11]. Case studies provide further insights into the practical implications of automation [12]. Secondary data from industry reports strengthen the analysis [13]. This comprehensive methodology aims to deliver a nuanced understanding of automation's role in enhancing manufacturing effectiveness. To comprehensively analyze the impact of industrial automation on production metrics, this study employs a mixed-methods approach that combines qualitative and quantitative research methodologies. Qualitative data were collected through interviews and surveys with industry professionals, enabling the gathering of firsthand insights regarding the experiences and challenges associated with implementing automation technologies. These qualitative insights serve to contextualize the quantitative data derived from diverse sectors, including automotive and electronics manufacturing, focusing specifically on key performance indicators such as production volume, cost efficiency, and quality control metrics. The quantitative analysis involves the examination of production statistics and financial data to identify patterns and correlations related to automation adoption [11]. Additionally, the research incorporates relevant case studies to provide concrete examples of automation's impact on various industries [12]. Secondary data from industry reports and academic articles further strengthen the analysis, ensuring a robust understanding of automation's role in enhancing manufacturing effectiveness. This comprehensive methodology aims to deliver a nuanced exploration of the benefits and challenges of automation, providing valuable insights for organizations considering or currently implementing automated systems.

Comparative Analysis

Production Volume

Automation significantly boosts production volume, enabling continuous operation without interruptions typical of human labor [14]. Industries such as automotive and electronics leverage robotics for assembly and inspection, resulting in marked increases in output [15]. For example, companies report up to a 50% increase in production capacity after implementing automated systems [16]. Additionally, automation allows for rapid scalability, enabling manufacturers to adjust production levels based on fluctuating demand [17]. Enhanced consistency in quality control reduces defects and waste, further contributing to higher production volumes [18]. The clear correlation between automation and improved production efficiency positions automated systems as essential for meeting market demands and achieving competitive advantage.

The introduction of automation technologies significantly enhances production volume across various industries by enabling continuous operation and reducing bottlenecks associated with manual labor. Automated systems, such as robotics and AI-driven machines, facilitate streamlined workflows, allowing manufacturers to increase output while minimizing human error. In industries like automotive and electronics, where precision and speed are paramount, automation has been shown to boost production capacity by up to 50% [16]. Furthermore, automation enhances scalability, enabling manufacturers to adjust production levels in response to fluctuating market demands without compromising efficiency. The implementation of automated quality control processes also contributes to higher production volumes by reducing the occurrence of defects and waste, further optimizing resource utilization [18]. As companies seek to improve their competitive edge, investing in automation not only addresses current production challenges but also positions them for future growth by fostering innovation and enhancing responsiveness to changing consumer preferences. Overall, the correlation between automation and increased production volume underscores the strategic importance of adopting automated solutions to meet market demands and drive long-term success in manufacturing.



**Swain and Ranjan Behera****Cost of Production**

While the initial costs of implementing automation can be significant, the long-term financial benefits often outweigh these expenditures [19]. Automation reduces labor costs, minimizes operational inefficiencies, and lowers overall production expenses [20]. Companies frequently observe ROI within three to five years, as savings accumulate from decreased labor and enhanced efficiency [21]. Additionally, automated systems help mitigate the risks of human error and equipment downtime, further driving down costs [22]. However, organizations must also account for ongoing maintenance and technological upgrades as part of their total investment [23]. Understanding these cost dynamics is crucial for businesses aiming to leverage automation for sustainable growth and competitiveness [24].

While the upfront costs of implementing automation technologies can be substantial, the long-term financial benefits often outweigh these initial investments. Automation plays a pivotal role in reducing labor costs by minimizing the reliance on human workers, allowing organizations to achieve significant savings in wage expenses over time [20]. Moreover, automated systems enhance operational efficiency, which translates into reduced production costs through decreased material waste and improved resource allocation [21]. Companies frequently experience a return on investment (ROI) within a span of three to five years as savings from increased productivity and lowered labor costs accumulate [21]. Additionally, automation mitigates the risks associated with human error, further driving down costs related to rework and defective products [22]. However, organizations must consider ongoing maintenance and the necessity for technological upgrades as part of their total investment strategy [23]. Understanding these cost dynamics is essential for businesses aiming to leverage automation not only to enhance productivity but also to achieve sustainable growth and remain competitive in an ever-evolving marketplace.

Case Studies**Automotive Industry**

The automotive industry exemplifies the transformative impact of automation, where robotic systems have revolutionized production processes [25]. Leading manufacturers like Ford and Toyota have adopted advanced robotics to enhance assembly line efficiency [26]. These innovations have resulted in significant increases in production volume and consistency, with reports indicating up to a 50% boost in output [27]. Furthermore, automation reduces labor costs and enhances product quality by minimizing errors associated with manual labor [28]. As competition intensifies, companies that embrace automation not only achieve operational efficiency but also position themselves for innovation and responsiveness to market changes, solidifying their competitive edge in the industry [29]. The automotive industry serves as a prime example of how automation can revolutionize manufacturing processes. Leading manufacturers such as Ford and Toyota have adopted advanced robotics to enhance assembly line efficiency and streamline production workflows. The implementation of automated systems has resulted in substantial increases in production capacity, with some companies reporting up to a 50% boost in output following automation adoption [26]. Furthermore, automation minimizes labor costs and enhances product quality by reducing the potential for human error, which is critical in a sector where precision is paramount [27]. As competition intensifies, automotive firms that embrace automation not only improve their operational efficiency but also position themselves to innovate and adapt swiftly to market changes. The integration of technologies such as AI and machine learning further enhances predictive maintenance and process optimization, ensuring that manufacturers can maintain their competitive edge. By leveraging automation, the automotive industry demonstrates the potential for significant productivity gains, showcasing how technological advancements can reshape traditional manufacturing paradigms.

Electronics Industry

In the electronics industry, automation has significantly enhanced manufacturing capabilities, particularly regarding precision and speed [30]. Companies like Samsung and Apple utilize sophisticated robotic systems for assembling and inspecting complex components [31]. This technological shift has resulted in higher production rates and improved product quality, with automated systems capable of performing tasks with minimal defects [32]. Furthermore, automation allows for rapid scalability, enabling manufacturers to respond quickly to changing consumer demands [33]. The adoption of automation not only streamlines production but also fosters innovation,



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allowing firms to invest in research and development while ensuring competitiveness in a fast-paced market environment [34]. The electronics industry exemplifies the transformative effects of automation, particularly in enhancing precision and speed within manufacturing processes. Major companies like Samsung and Apple have successfully integrated sophisticated robotic systems into their production lines, particularly for the assembly and inspection of intricate electronic components. This technological shift has resulted in notable increases in production rates, with automated systems capable of executing tasks with exceptional accuracy and minimal defects [32]. Additionally, automation allows for rapid scalability, enabling manufacturers to respond promptly to changing consumer demands without sacrificing quality. The implementation of automation not only streamlines production but also fosters an environment of continuous improvement and innovation, as firms are able to reallocate resources towards research and development. By embracing automation, the electronics industry positions itself to meet the challenges of a fast-paced market while ensuring the delivery of high-quality products. The success of automation in this sector highlights the critical importance of adopting advanced technologies to maintain competitiveness and efficiency in the ever-evolving landscape of electronics manufacturing.

Food Production

The food production sector has increasingly turned to automation to improve efficiency and maintain high standards of quality [35]. Automated systems streamline operations from raw material handling to packaging, enhancing throughput while ensuring food safety. Major companies like Nestlé have successfully integrated robotics into their processes, resulting in consistent product quality and reduced contamination risks. Additionally, automation contributes to sustainability by optimizing resource use and minimizing waste [33]. With rising consumer expectations for efficiency and quality, automation in food production emerges as a vital strategy for manufacturers seeking to enhance competitiveness while complying with regulatory standards [28].

In the food production sector, automation has emerged as a crucial strategy for improving operational efficiency while adhering to stringent safety and quality standards. Automated systems streamline various processes, from raw material handling to packaging, thereby enhancing throughput and minimizing the risk of contamination. Major companies like Nestlé have successfully integrated robotics into their manufacturing processes, achieving consistent product quality while reducing the chances of human error [16]. Furthermore, automation plays a significant role in promoting sustainability by optimizing resource use, reducing waste, and enhancing traceability throughout the supply chain. As consumer expectations for efficiency and quality continue to rise, the food production industry increasingly recognizes automation as a vital tool for maintaining competitiveness and ensuring compliance with regulatory standards [28]. By embracing automation technologies, food manufacturers can enhance their operational capabilities, improve their responsiveness to market trends, and ultimately deliver superior products to consumers. This integration of automation within the food sector underscores the importance of technological advancements in achieving efficiency, quality assurance, and sustainability.

DISCUSSION**Trends in Automation**

The evolution of industrial automation is closely linked to the principles of Industry 4.0, characterized by smart manufacturing and interconnected systems [19]. As technologies like IoT and artificial intelligence become integral to production processes, manufacturers gain access to real-time data analytics that optimize operations [30]. Smart factories utilize predictive maintenance to minimize downtime and enhance resource allocation, leading to improved efficiency and productivity [21]. Collaborative robots (cobots) further signify a shift toward human-robot cooperation, enhancing workplace safety while increasing output [32]. These trends indicate a transformative future for manufacturing, where organizations that embrace automation can achieve greater customization, efficiency, and competitiveness [3].

The ongoing evolution of industrial automation is intricately linked to the principles of Industry 4.0, characterized by the integration of smart manufacturing technologies and interconnected systems. As the Internet of Things (IoT),



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artificial intelligence, and big data analytics become more embedded in manufacturing processes, organizations can leverage real-time data to optimize operations and drive efficiency [39]. Smart factories utilize predictive maintenance techniques to minimize equipment downtime, enhance resource allocation, and improve overall productivity. Additionally, the rise of collaborative robots (cobots) signifies a shift toward human-robot collaboration, wherein machines assist human workers rather than replace them, fostering workplace safety and boosting output [12]. These trends indicate a transformative future for manufacturing, where organizations that embrace automation will achieve greater customization, flexibility, and efficiency. Moreover, the integration of advanced technologies can enable manufacturers to develop innovative products and services that meet evolving consumer demands, ultimately ensuring their long-term viability and competitiveness in an increasingly complex marketplace. As such, staying attuned to these trends is vital for organizations seeking to navigate the challenges and opportunities presented by the evolving landscape of industrial automation.

Challenges of Automation

Despite its benefits, industrial automation presents several challenges that organizations must navigate [24]. Job displacement remains a significant concern, as automation can reduce the demand for manual labor in various sectors [5]. This situation necessitates workforce retraining and reskilling initiatives to prepare employees for new roles in an automated environment [16]. Additionally, the substantial initial investments required for automation technologies may pose financial challenges, particularly for small and medium-sized enterprises [7]. Integrating new automated systems with existing infrastructures can also be complex and resource-intensive [18]. Moreover, cybersecurity risks associated with interconnected automated systems highlight the need for robust security measures to protect against potential threats [29]. Despite the myriad benefits associated with industrial automation, organizations must confront several challenges that can impede successful implementation. One of the most pressing concerns is job displacement, as automation may reduce the demand for manual labor in various sectors, leading to workforce reductions and associated social implications [25]. To address this challenge, companies must invest in retraining and reskilling initiatives that prepare employees for new roles in an increasingly automated environment [16]. Furthermore, the substantial upfront investment required for automation technologies may pose financial hurdles, particularly for small and medium-sized enterprises that may lack access to capital [7]. Integrating new automated systems with existing infrastructures can also be complex and resource-intensive, necessitating careful planning and execution to minimize disruption [18].

CONCLUSION

Industrial automation is a pivotal force shaping modern manufacturing, driving efficiencies in production volume and cost management. This article has examined the profound impact of automation on these metrics, illustrating how companies that adopt automated systems can enhance their operational effectiveness and remain competitive in an evolving marketplace. The comparative analysis highlights that, despite the initial financial burden, the long-term benefits—such as increased output, reduced labor costs, and improved quality control—often justify the investment. As trends toward smart manufacturing continue, the strategic adoption of automation will be crucial for organizations seeking to navigate the challenges of the future and capitalize on new opportunities for growth and innovation. Industrial automation is a crucial driving force in shaping contemporary manufacturing practices, significantly influencing production volume and cost structures. This article has explored the extensive implications of automation on these metrics, demonstrating how companies that adopt automated systems can enhance their operational effectiveness and remain competitive in an increasingly dynamic marketplace. The comparative analysis indicates that, despite the initial financial burden associated with automation, the long-term benefits—such as increased output, reduced labor costs, and improved quality control—often justify the investment. As trends toward smart manufacturing continue to evolve, the strategic adoption of automation will be vital for organizations seeking to navigate future challenges and capitalize on new growth opportunities. By understanding the intricate relationship between industrial automation, production volume, and cost, manufacturers can position themselves for





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success, ensuring their ability to adapt to changing market conditions while delivering high-quality products and services to consumers.

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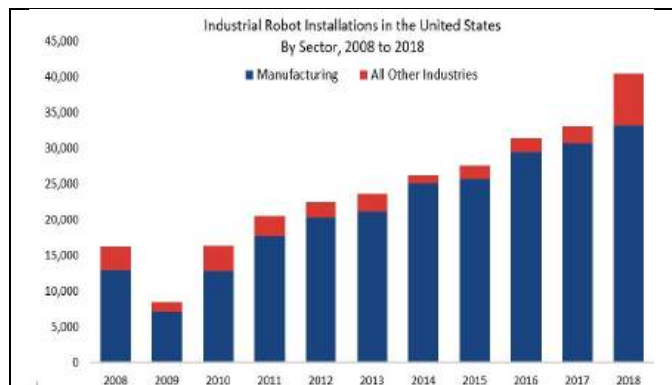


Figure 3: Increase in Production Volume Post-Automation across Different Industries.

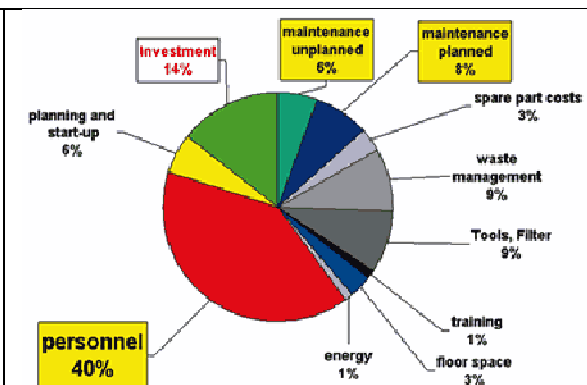


Figure 4: Cost Breakdown of Automation Implementation in Manufacturing.

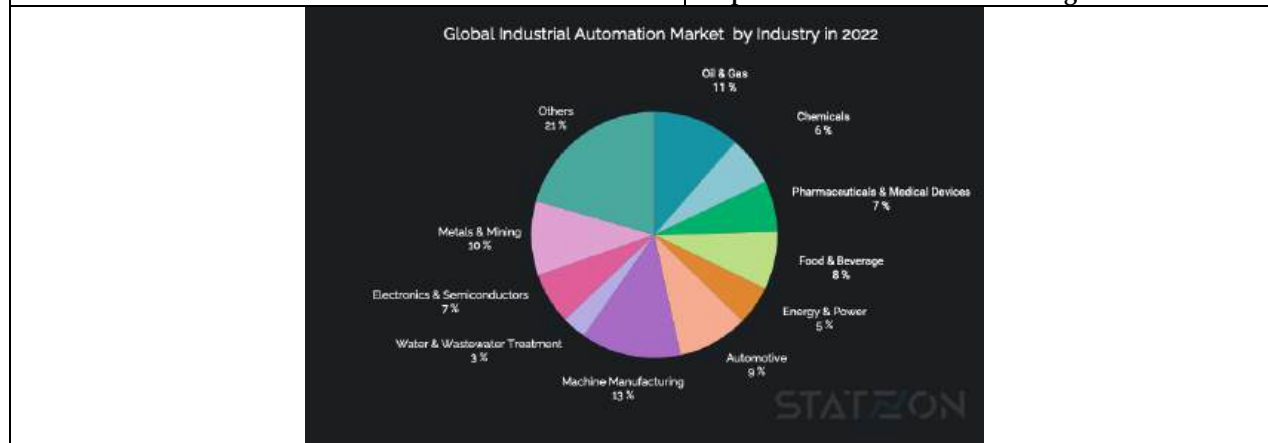


Figure 5: Case Study Highlights of Automation Success in Diverse Manufacturing Sectors.





Principles of Electric Vehicles: Components and Types

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ABSTRACT

“This article demonstrates an in-depth knowledge of the fundamental principles of electric Vehicles, basic types and functions of various components of an Electric vehicle. The history and the evolution of Electric vehicles are presented with a diagram. The technology behind how an Electric vehicle works is demonstrated with a case-study. The components and sub-systems are described with a pictorial presentation. Comparison of Electric vehicles with conventional vehicles and the benefits of Electric vehicles are presented. Further, the emerging trends and challenges in an Electric vehicle industry are addressed. The article also highlights the significance of Electric Vehicles in context of sustainable mobility in the automobile sector for the future generation”.

Keywords: Electric Vehicles (EVs), Components of EVs, Sub-systems of EV, Principles of EV, EV-Applications, Market strategies of EVs,



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INTRODUCTION

“An Electric vehicle (EV) is a vehicle propelled by an electric motor. Electric vehicles run on electricity and these are also known as battery-electric vehicles [1]. They use an electric motor rather than an internal combustion (IC) engine. Running costs are extremely low because there are fewer moving parts to maintain. The vehicle produces no exhaust gases because it is powered by electricity” [2]. “Electric vehicles, also known as battery electric vehicles (BEVs), rely solely on electricity stored in a battery pack to power an electric motor, unlike conventional internal combustion engine vehicles that burn fossil fuels [3]. Since EVs do not have tailpipes and do not produce exhaust emissions during operation, the U.S. Environmental Protection Agency (EPA) classifies them as zero-emission vehicles” [4]. However, it's important to note that while the vehicles themselves emit no direct pollution, the electricity used to charge them may still be generated from sources that contribute to air pollution, such as coal or natural gas [5]. The environmental impact of EVs can thus depend on how “clean” the energy grid is in a particular area, and charging with renewable energy sources like wind, solar, or hydro can further reduce the overall emissions associated with EVs [6]. Additionally, the adoption of EVs is part of broader efforts to reduce reliance on fossil fuels, improve air quality, and combat climate change [7]. With advances in battery technology and charging infrastructure, EVs are becoming a more viable and environmentally friendly transportation option for many [8]. An EV uses electric motors powered by batteries or other energy storage, instead of relying on internal combustion engines that burn fossil fuels [9]. EVs are recognized for their ability to reduce emissions, enhance energy efficiency, and provide a more sustainable transportation option compared to traditional vehicles [10].

Working Principle of an Electric Vehicle

Electric vehicles use electric motors powered by energy stored in batteries, which they recharge from the grid via charging stations [11]. This direct use of electricity makes EVs highly efficient and allows for quicker acceleration due to the instant torque provided by electric motors. Unlike internal combustion engines (ICE), where power is gradually built, electric motors deliver their full torque immediately, giving EVs that rapid, responsive feel when accelerating [12]. Additionally, EVs have fewer moving parts than conventional fuel-powered vehicles, resulting in lower maintenance costs [13]. Their quiet operation and the absence of tailpipe emissions are also major benefits, contributing to a smoother driving experience and a reduced environmental impact [14]. “Electric vehicles function by plugging into a charge point and taking electricity from the grid. They store the electricity in rechargeable batteries that power an electric motor, which turns the wheels” [15].

- “Electric vehicles accelerate faster than traditional fuel engines [16].
- When the pedal is pressed, the controller gathers energy from the battery.
- Controller delivers the appropriate amount of electrical energy to the motor.
- Motor convert electrical energy transforms to mechanical energy.
- Wheels turn and vehicle moves” [17].

Steps of Working of an EV

Step I: The controller transfers and manages electrical energy from the battery to the inverter [18].

Step II: The inverter transmits a specific amount of electrical energy to the motor [19].

Step III: The motor transforms electrical energy into rotational mechanical energy.

Step IV: The vehicle moves when the wheels turn as a result of the motor rotor's rotation spinning the transmission [20].

Step V: The motor turns into an alternator and produces power when the brakes are applied, which are then returned to the battery [21].





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Types of Electric Vehicles

“Battery Electric Vehicle (BEV): Powered entirely by electricity. These are more efficient than hybrids and plug-in hybrids. BEVs are frequently referred to as all-electric vehicles (AEV). Electric vehicles equipped with BEV technology run fully on a battery-powered electric drive train. The electricity needed to power the vehicle is stored in a massive battery pack, which can be recharged by connecting to the power grid. The charged battery pack then powers one or more electric motors, which drive the electric car. Different types of EVs are depicted in Fig 1” [20].

“Hybrid Electric Vehicles (HEV). The vehicle's power train consists of an internal combustion (typically petrol) engine and a battery-powered motor. When the battery is empty, the petrol engine is used for both driving and charging. These vehicles are less efficient than all-electric or plug-in hybrid automobiles. HEVs are also referred to as series or parallel hybrids. HEVs contain both an engine and an electric motor. Fuel provides energy to the engine, while batteries supply power to the motor. The transmission is rotated simultaneously by the engine and the electric motor, which drives the wheels” [24].

“Plug-in Hybrid Electric Vehicle (PHEV): Has both an internal combustion engine and a battery that is charged via an external socket (a plug). This means that the vehicle's battery can be charged using electricity rather than the engine. PHEVs are more efficient than HEVs, but not as efficient as BEVs. They have an engine and a motor. One can pick between conventional fuels (gasoline) and alternative fuels (such as biodiesel). It may also be powered by a rechargeable battery pack and can be recharged externally” [10].

“Fuel cell electric vehicle (FCEV): A FCEV generates electricity from chemical energy. For example, consider a hydrogen fuel cell vehicle. FCEVs are often referred to as Zero Emission Vehicles. They use 'fuel cell technology' to generate electricity needed to operate the car. The chemical energy of the fuel is directly transformed to electric energy” [25].

Main Components of an Electric Vehicle

The followings are important and essential components in a electrical vehicles [22].

The components and specifications of an EV are presented in Table 1 and Fig 2.

1. Battery: “It supplies the cars with electricity.
2. Charge Port: The charge port enables the car to be connected to an external power source for battery recharging [23].
3. DC/DC converter: This device changes battery-derived higher voltage DC power into lower voltage DC power.
4. Electric Motor: The car's wheels are powered by an electric motor [24].
5. Onboard charger: This device charges the battery by converting AC power to DC power.
6. Power electronics controller: It regulates the speed and the flow of electrical energy from the battery to the motor [25].
7. Thermal system (cooling): It keeps the engine, motor, etc., within the appropriate operating temperature range [26].
8. Transmission: It transfers mechanical power from the motor to drive the wheels”.

RESULTS AND DISCUSSION

Mechanism of an Electric Vehicle is illustrated in Fig 3.

1. Take AC Input via wire charger from charging station infrastructure to battery bank.
2. The battery provides a 48V DC power output to the controller.
3. Accelerator gives signal to the controller.
4. Accordingly controller gives the output to the motor.
5. Motor converts Electrical energy to Mechanical energy and it gives torque to move the vehicle.





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Advantages and Disadvantages of Electric vehicles

Advantages

- a. Electric vehicles are energy efficient.
- b. They cut emissions.
- c. It provides excellent performance while requiring minimal maintenance.
- d. It can be fuelled for a minimal cost.
- e. It is more convenient and simple to recharge.

Disadvantages

- a. Electric cars can go shorter distances.
- b. Refueling takes longer, is more expensive,
- c. Battery packs may need to be changed.
- d. Electric fueling facilities are still in development.
- e. The initial investment is extremely high.

Challenges and Solutions in Sustainable Mobility

- Sustainable mobility: Achieving net-zero emissions by 2075 requires a multi-pronged approach, including EVs, improved public transport, and infrastructure development.
- EV infrastructure: Building a robust network of charging stations and domestic battery production are crucial for large-scale EV adoption.
- Expert consensus: Industry leaders acknowledge EVs as the future, but India needs to invest in infrastructure and manufacturing.
- **Goal:** Achieving net-zero emissions by 2075.
- Infrastructure Development: A robust network of charging stations is essential for widespread electric vehicle (EV) adoption.
- Domestic Battery Production: Building local manufacturing capabilities for batteries is critical.
- Public Transport Improvements: Enhancing public transport systems to complement EVs.
- Expert Consensus: Industry leaders agree that while EVs are the future, significant investment in infrastructure and manufacturing is necessary.

Overall, the future of EVs in India is promising, but overcoming infrastructure and manufacturing hurdles is essential. By addressing these challenges, India can unlock its potential to be a leader in the EV revolution.

CONCLUSION

The future of Electric vehicles in India looks promising, driven by a booming transportation sector and a large population seeking sustainable options.

Addressing infrastructure and manufacturing challenges is vital to realizing the country's potential as a leader in the EV revolution. The country presents a significant market opportunity for EVs, especially as it aims to reduce dependence on fossil fuels and meet climate goals. Key components of EVs include batteries, electric motors, and charging infrastructure, which are essential for widespread adoption. This shift towards EVs not only addresses transportation needs but also supports India's commitment to environmental sustainability.

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Table1. Components and Specifications of an Electric-Vehicle

S. No.	Component	Specifications
1	Battery	Lead-acid battery; Voltage- 48V; Capacity-80-100Ah; Deep Charge cycle-1800cycles
2	Motor	Motor (Brushless-DC); Rated Voltage-48V Rated Current-25A Rated Speed-3000rpm
3	Controller	Power-1000W; Voltage- 48V DC;
4	Converter	Converter (DC-DC); Input Voltage- 48V; Output Voltage- 12V; Output Current-10A;
5	Power and Signal Distribution	Assembly of Multiple cables used for power and signal distribution





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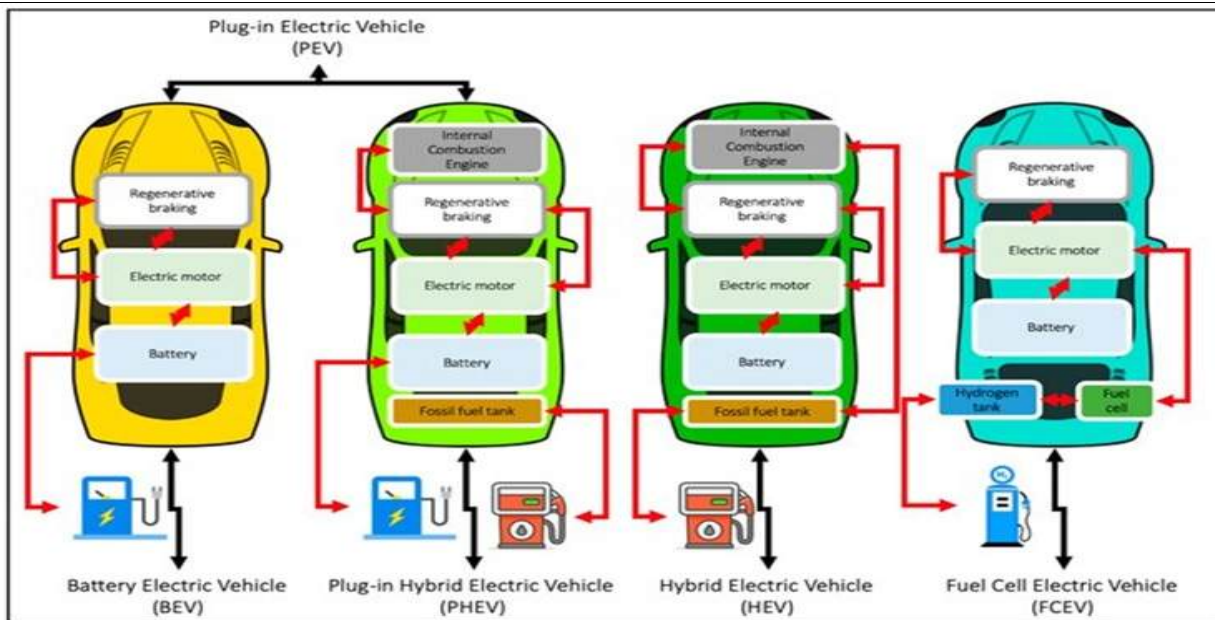
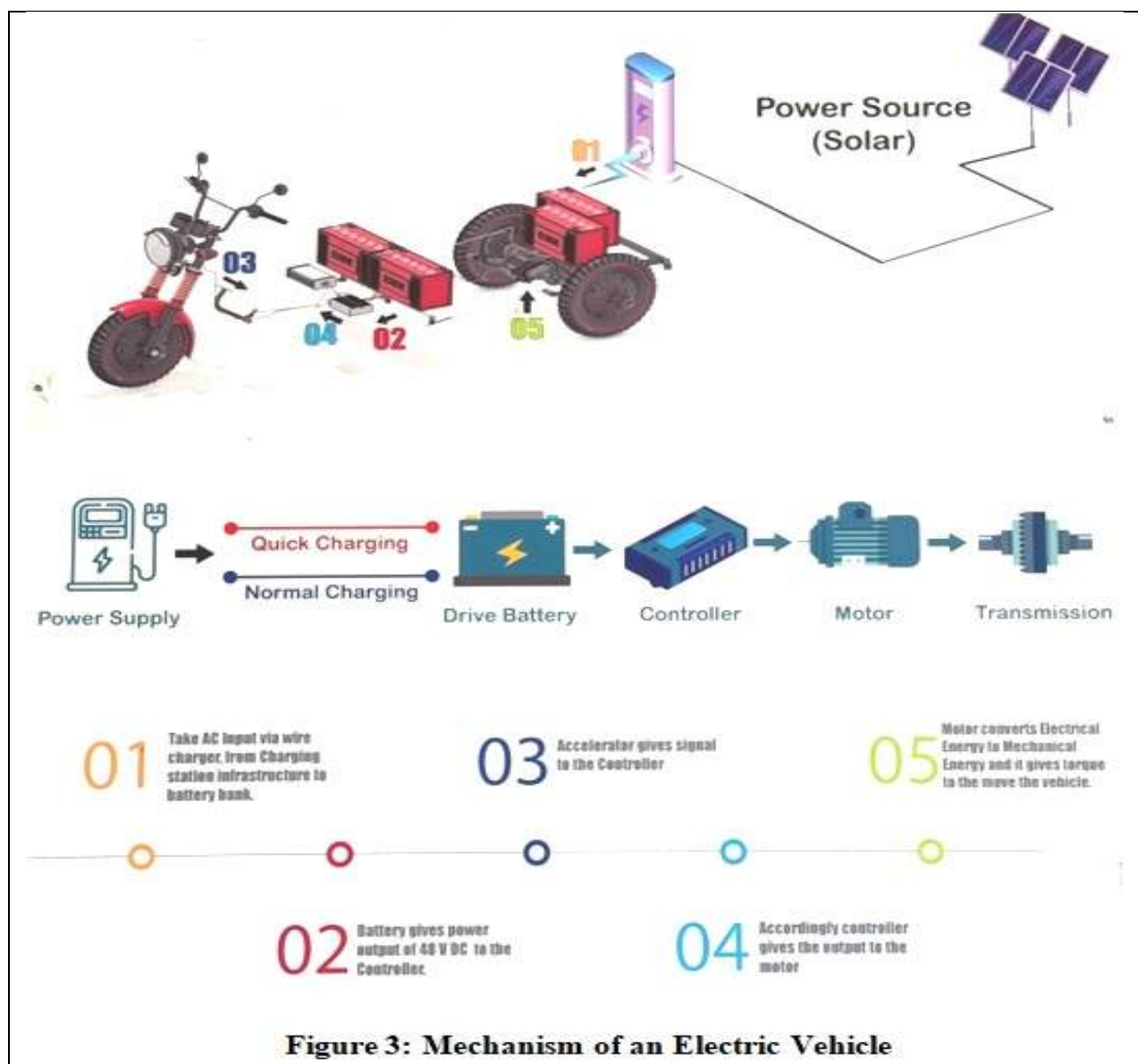


Figure 1: System Architecture of Types of Electric vehicles



Figure 2: Components of an Electric Vehicle







Structural Properties Porous Nature of Newly Developed NEG Materials

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ABSTRACT

Non-Evaporable Getter (NEG) applications are increasing a lot in the present days. For many applications these NEG materials are used at high temperatures. The current study briefly discusses the structural properties and porosity nature of newly developed getter materials with rare earth (RE-Samarium and Gadolinium) elements substitutions. The present selected materials Zr-Co, Zr-Co-(Sm+Gd) with different compositions. These are made using Solid State Reaction method process also the alloys are activated 1000°C temperature. These results can be analyzed by using X-ray Diffraction (XRD) for structural analysis, Scanning Electron Microscope (SEM) with Energy Dispersive Spectroscopy (EDS) for morphological, atomic and elemental concentrations, Transmission Electron Microscopy (TEM) for micro-structural, average particle size. The present work is to study the structural parameters and porosity nature comparison of pure and rare-earth substituting NEG alloys.

Keywords: Porosity; Structural properties; Zr-Co, Zr-Co-RE NEG materials; activation temperature.

INTRODUCTION

The getters are expected to have maximized surface to volume ratios with high porosity facilitating to access the gas to be pumped to the internal areas of the getter. The combination of these four series of materials is assumed to provide good mechanical characteristics facilitating them to be the suitable getters for required conditions[1-3]. A simple and reliable method for determining the porosity of a solid sample is adopted in the present study that involves use of its lattice constant value. In the past few years, many NEG alloys have been used for different





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applications in vacuum technology. For these reasons, the Zr-V-Ti, Zr-V-Fe, Zr-Al, and Zr-Co non-evaporable getter alloys were widely used to achieve better vacuum-type devices [4, 5]. Also, these support inside chemical reactions of getter and gases to maintain good vacuum conditions in the machines. The primary need for non-evaporable getter materials is high activation temperature, high resolvability limitation and high conductivity to the absorbed categories, high temperature and high chemical strength [6]. The NEG materials with the high activation temperature are Zr-Coalloys. Therefore, NEG materials are essential for obtaining and maintaining vacuum conditions for ultra-high or extremely ultra-high vacuum systems. This paper discussed the structural properties, morphologies, microstructure, and porosity nature performance of substituting rare-earth elements Sm and Gd of NEG getter materials [7-10].

Experimental Details of NEG Materials

The composition of the NEG getter alloys is derived from stoichiometry ratios starting with Zr, and Co metal powders from Sigma Aldrich (99.99%) and rare-earth (RE) components Samarium and Gadolinium metal powders from Merck (99.99%). The chemical compositions $Zr_{700+x}Co_{297-x}$ and $Zr_{700+x}Co_{297-x}(Sm+Gd)_3$ are synthesized, where $x=0, 40, 80, 120$ in steps. The mixed raw powder material was first thoroughly milled for 15 hours using an agate mortar and pestle to add methanol solvent to bind the substance. This combined powder material was heated in a muffle box furnace for 1 hour at 350°C to remove the moisture content in the metal powder. When the heated powder material has cooled to its normal temperature, it is grinding again for 1 hour to make the materials well blended. The powder material to make into pellets in round discs using a KBr Hydraulic Pellet Presser with a pressure of 3 tonnes for 5 minutes on the pellet machine to generate NEG alloys. These are sintered in a muffle furnace at 1000°C for 2 hours to make non-evaporable getter alloys. The XRD patterns of both series of materials were obtained using a Panalytical X-pert pro-diffract-meter with diffraction angles ranging from 10° to 80° in 0.02° steps. A transmission electron microscope (TEM) made by the Philips Company, a scanning electron microscope (SEM), and an energy dispersive spectrometer (EDS) made by JEOL were used to look at the materials' shapes and how they were made.

RESULTS AND DISCUSSION

X-ray Diffraction Studies

The XRD technique is a universally accepted method to determine the behavior of the crystal and its structure. The material is basically in the form of powder, comprising fine particles of material with a single crystalline to be studied. This technique is extensively utilized for structure analysis, structure determination, crystallite size, lattice constant, texture and electron radial distribution functions. The XRD analysis for the synthesized getter material is carried out to study the relation between crystallographic properties and their variation with rare earth elements substitution. The lattice constant and XRD patterns measure the cell volume of each sample to assess the influence of RE element replacements on the crystalline lattice of the better-getter materials developed. In Fig 1 $Zr_{1-x}Co_x$ series exhibits six fingerprint peaks at hkl values (1 0 0), (1 1 0), (1 1 1), (2 0 0), (2 1 0), and (2 1 1) are matches with JCPDS Card No #00-018-0436 [11, 12]. The acquired Zr-Co₂ phase also exhibits cubic structure and reflects very low intense diffraction peaks corresponding to (2 2 0), (4 0 0) and (4 4 0) planes respectively (JCPDS card no. 00-153-2069). The present (Zr-Co) NEG alloys are evaluated considering the FWHM of the most intense diffraction peak (1 0 0) values of inter planer spacing (d) = 3.985(Å), lattice constant (a) = 6.903 (Å), FWHM = 0.2350, and crystalline size of Zr-Co series getter materials is D = 34.422 nm. The XRD pattern of (Zr-Co-RE) getters at different concentrations of RE in Fig 2. The (Zr-Co-RE) series is observed to contain 11 major fingerprint peaks at (0 0 2), (1 1 0), (0 4 0), (1 1 2), (1 3 1), (0 2 4), (1 3 3), (0 2 5), (2 2 2), (0 8 0) and (1 7 3). The observed h, k, l values are legibly identified with JCPDS Card No # 00-152-4752. It is interesting to note that five strong peaks were found around $2\theta = 34.17^\circ, 38.47^\circ, 43.71^\circ, 53.97^\circ$ and 75.94° . These are corroborated with the earlier investigations [13, 14]. The orthorhombic structure Zr_3Co , which has a stronger activation condition is a base-centered orthorhombic lattice system that permits to translate into one of the base planes and the related space group (63. Cmc₂m). The values of these peaks corresponding Bragg angles and the lattice parameter (a) are calculated by using Unit Cell software.



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By using Debye-Scherrer's equation [15], the crystallite sizes of the present (Zr-Co-RE) NEG alloys are evaluated considering the FWHM of the most intense diffraction peak (1 1 2). All these values are listed in Table 4.2. At higher temperatures, the crystalline size increases with increasing Zr concentration. The values of d-spacing and peak intensities increase as a function of Zr concentration. The FWHM is found to decrease with the reduction of Co concentration. The standard average lattice parameters of the orthorhombic crystal structure are $a=3.43\text{\AA}$, $b=10.85\text{\AA}$ and $c=8.78\text{\AA}$. Also, the volume is $317.25\text{\AA}^3$. This significantly enhances the absorption capacity of these alloys. Other small diffraction peaks of ZrO_2 phases of the orthorhombic structure are observed at $2\theta=33.84^\circ$, 35.12° , 61.29° , 68.38° and 78.94° corresponding to (0 2 0), (0 0 2), (3 1 1), (1 2 3) and (3 3 0) peaks with JCPDS card no. 00-154-5065. One more minute diffraction peak of the CoO_2 phase, which has orthorhombic structure also observed at $2\theta=52.85^\circ$, 61.05° , 75.42° , and 77.19° correlated to (2 0 9), (2 0 11), (0 2 8) and (2 0 15) peaks with JCPDS: 00-152-6822. This shows the property or behavior relating to sorption profile of these alloys [16, 17, 18]. The present (Zr-Co-RE) NEG alloys are evaluated considering the FWHM of the most intense diffraction peak (1 0 0) values of 'd' spacing ($d=4.401(\text{\AA})$), lattice constant ($a=3.401$, $b=10.91$, $c=8.68(\text{\AA})$), full width at half maximum (FWHM)= 0.524θ , and crystalline size of Zr-Co-RE series getter materials is $D=153.980\text{nm}$.

Density and Porosity Analysis

The experimental arrangement for bulk (d_b) and X-ray (d_x) densities (gm/cm^3) lattice constant ($\text{\AA}$) besides porosity (%) particle size (D), Specific Surface Area (S), Dislocation (δ) and Micro Strain (ϵ) of the present NEG getter materials with different concentrations has been measured, the obtained with $\text{Zr}_{1-x}\text{Co}_x$ where x varies between $x=0.36$ to 0.20 in different concentration of 0.04 and $\text{Zr}_{1-x}\text{Co}_{x-3}\text{RE}_3$ where x concentration weights between $x=0.30$ to 0.18 in steps of 0.04 values are presented in the Table 1 and 2. From Tables, the lattice parameter increasing with decrease of x is the finding of this paper [19, 10]. Lattice parameter increases when there is occupation of the interstitial place thus relaxation of the bond occurs. Lattice constant of pure zirconium is $3.1\text{\AA}$. The particle size D depends upon the FWHM of the highest peak of the XRD spectrum. These are two different samples with different X-ray characteristics. So, there should be comparison between the same series rather than others.

From Table 1 and 2 the lattice parameter increasing with decrease of x is the finding of this work. Lattice parameter increases when there is occupation of the interstitial place thus relaxation of the bond occurs. Lattice constant of pure titanium is $2.95\text{\AA}$ and of pure zirconium is $3.1\text{\AA}$. The particle size D depends upon the FWHM of the highest peak of the XRD spectrum. These are two different samples with different X-ray characteristics. So, there should be comparison between the same series rather than others. The Surface area is inversely proportional to the particle size. As after addition of RE particle size increased so the surface area decreased [23]. The values of lattice parameter, density and porosity are found to show improvement than pure elements as a function of substituting rare earth elements (RE). This may be due to the enhanced compactness of particles in their binding resulting in a raised density of materials. This may be understood with the increase in molecular weight of the samples due to their composition causing to increase the substitution of rare earth elements. The irregularity within a crystal structure that contains an abrupt change in the arrangement of atoms (dislocation) and the degree of distortion present in the crystalline lattice (micro strain) also decreases with the RE substitution. With substitution of RE elements, the porosity of the NEG materials is increased. It enhances the residual gases absorption rate causing more applicability in vacuum generations [24, 25].

Scanning Electron Microscope with EDS (EDX) Study

The SEM images of pure $\text{Zr}_{1-x}\text{Co}_x$ where x varies between $x=0.36$ to 0.20 in steps of 0.04 and $\text{Zr}_{1-x}\text{Co}_{x-3}\text{RE}_3$ where x concentration weight between $x=0.30$ to 0.18 in steps of 0.04 shown in Fig. 3 & 4. In the Zr-based NEG specimens (Zr-Co), the bulk diffusion decreased with the rise of substituent concentration (x) may be due to causing reduced Zirconium content. The average particle size value appears to be diminishing as a function of x , and the computed particle size values agree with the crystallite size values obtained based on XRD measurements [10, 20, 26]. The observed porous structure on the surface of Zr-Co series nanostructure could reflect a higher capacity of gas absorption this NEG materials nature. The structural stability of the (Zr-Co-RE) NEG materials are investigated by





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using EDS. Besides the free energy deposition of Zr, Co, and RE oxides, no other impurity peaks are exhibited in the spectra. As shown in Fig.3 and 4 the most stable compounds are ZrO_2 and Co_2O_3 . The obtained values of element weight % and atomic weight % for the series of Zr-Co and Zr-Co-RE are shown in the Fig. The quantity of zirconium, cobalt, samarium, and gadolinium elements found to be good as element weight %, atomic weight % and the results of EDS confirm the expected stoichiometry [26, 27].

Transmission Electron Microscope Study

Microstructure and related parameters such as average grain size and grain growth type, which determine the mechanical strength of materials, can be aided by morphological analysis. For RE substitution (Sm&Gd), the obtained micrographs of the Zr-Co and Zr-Co-RE series of NEG materials are shown in Fig.5 and 6. The grain distribution in these photos Zr-Co, Zr-Co-RE NEG series have average grain sizes and porosity nature calculated to displayed in the Table 3. The TEM micrographs in the pictures show that the NEG materials effectively absorb residual gases in both cases. The fact that the two series nano-sized of rare earth substituted series improve the specific surface area and grain boundaries, allowing for fast gas diffusion, is remarkable. Because of the microstructure alteration, this could be an excellent way to increase the absorption rate of NEG materials [28]. The selected-area electron diffraction (SAED) patterns reflecting round circles at the middle point show that the grain sizes of the NEG samples lie in the nanocrystalline range. The obtained micrographs of pure Zr-Co and RE elements substituted and Zr-Co-RE series of NEG materials are indicating the enhanced values of average grain sizes and porosity for both the series relative to the RE elements non – substituted series (pure) [29, 30].

CONCLUSIONS

The effects of samarium and gadolinium (RE) in Ti-Co and Zr-Co non-evaporable getters are investigated in the present study, and the following conclusions are established. The non-evaporable getter materials (Zr-Co) and (Zr-Co-RE) were effectively synthesized at a temperature of 1000°C, and their structural properties and porosity nature were investigated.

- Based on the obtained XRD spectra, both series 1 (Zr-Co) are reflecting cubic crystalline structure containing point defects such as pores that spotted clearly among the crystal bonds. But the substitution of rare element, series 2 (Zr-Co-RE) exhibited cubic and orthorhombic crystalline structure. The substitution of rare earth element enhanced the bonding nature among molecules reflecting with very tight like a sponge, thus in contrast to the series 1 and 2 series getter materials, the porosity behavior and mechanical strength of the materials has been modified largely. Crystalline size was found to increase with the substitution of RE element in both the series of materials relative to pure series of materials.
- With the rise of titanium concentration, the lattice constant and the size of the particle were also found to enhance their values. The same trend has been observed in the case of Zr-Co getter materials series too. The lattice constant increases from 3.18 to 3.20 Å (Zr-Co) series while for Zr-Co-RE series the attained values of lattice constant are $a = 3.4$ to 3.5 , $b = 10.91$ to 10.97 and $c = 8.68$ to 8.81 Å.
- The getters need to contain maximized surface to volume ratios having high porosity facilitating to adsorb gas molecules to be pumped into the internal areas of the getter materials. The present materials i.e., the four series of materials found to show good mechanical characteristics making these getter materials suitable for required conditions. A standard method for determination of the porosity and density of solid samples is adopted in the present studies. The obtained values of density and porosity of rare earth elements (RE) substituted materials are found to show improvement than the pure specimens.
- According to the XRD results in both series, when the cobalt content lowers, the FWHM reduces. Inter atomic spacing, lattice parameter (a), volume of the cell (V), crystalline size (D), and Intensity (I) are all growing, and phase changes were shown in both series. When the lattice parameter is increased in both series, the NEG absorption increases more efficiently. The surface of the getter begins to pump more gases into the getter when these parameters are increased.





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- The SEM with EDS study indicated that sintering at higher temperatures results in porous pellets with increased specific surface area and gas sorption capacity in both series. In addition, the EDS graphs revealed the getter material's optimal weight and atomic percentage.
- According to TEM microstructure investigations, the crystalline size of XRD patterns is proportional to the rise in particle size in a series; the histogram patterns can illustrate given above. The adsorption capacities of the non-evaporable getter materials increase as the activation temperature increases and also porosity nature increase.

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Table 1: Variation of lattice constant 'a', X-ray (d_x) and bulk (d_b) densities (gm/cm³) porosity %, particle size (D), Specific Surface Area(S), Dislocation(δ) and Micro Strain(ε) of Ti_{1-x}Co_x and Zr_{1-x}Co_x where x varies in between x = 0.36 to 0.20 in steps of 0.04.

S.No	Con (x)	Lattice Constant (a)(Å)	X-ray-Density (d _x)	Bulk-Density (d _b)	Porosity %	D (nm)	Spe. Surf. Area (S)X10 ⁻³ per unit	Dislocation (δ)X10 ⁻³ (nm ⁻²)	Micro Strain (ε)X10 ⁻³
1	0.36	3.187	13.394	23.673	43.42	82.366	5.432	1.474	0.875
2	0.34	3.118	13.173	22.721	42.022	90.79	5.016	1.213	0.788
3	0.28	3.177	13.528	23.132	41.518	97.281	4.806	1.174	0.736
4	0.24	3.196	13.267	23.528	43.611	103.753	4.36	0.928	0.695
5	0.2	3.204	13.148	24.546	46.431	135.215	3.374	0.546	0.533

Table 2: Variation of lattice constant 'a', X-ray (d_x) and bulk (d_b) densities (gm/cm³) porosity %, particle size (D), Specific Surface Area(S), Dislocation(δ) and Micro Strain(ε) of Ti_{1-x}Co_x and Zr_{1-x}Co_x where x varies in between x = 0.36 to 0.20 in steps of 0.04.





Sr. No	Con (x)	Lattice Constant (a) (Å)	X-ray-Density (dx)	Bulk-Density (db)	Porosity %	D (nm)	Spe. Surf. Area (S)X10 ⁻³ per unit	Dislocation (δ)X10 ⁻³ (nm ⁻²)	Micro Strain (ε)X10 ⁻³
1	0.3	a=3.40b=10.91 c=8.682	17.316	35.626	51.24	140.28	2.471	0.508	0.084
2	0.26	a=3.45 b=10.55 c=8.79	17.424	36.314	52.018	144.86	2.37	0.476	0.080
3	0.22	a=3.39 b=11.00 c=8.86	17.812	35.662	50.053	141.47	2.381	0.499	0.082
4	0.18	a=3.52 b=10.972 c=8.8	18.161	36.513	5.261	145.57	2.269	0.471	0.075

Table 4.24: Obtained the grain size (nm) of Zr_{1-x}-Co_x and Zr_{1-x}-Co_{x-3}-RE₃ series NEG materials.

S.No.	Conc(x)	Zr _{1-x} -Co _x (nm)				Conc(x)	Zr _{1-x} -Co _{x-3} -RE ₃ (nm)			
		Avg. Grain Size (nm)		Porosity (%)			Avg. Grain Size(nm)		Porosity (%)	
		SEM	TEM	SEM	TEM			SEM	TEM	SEM
1	0.36	34.23	0.36	44.65	46.17	0.30	129.82	135.76	52.43	56.34
2	0.32	36.19	0.32	38.43	44.76	0.26	152.90	159.12	55.87	54.76
3	0.28	41.64	0.28	45.87	41.31	0.22	162.79	173.25	58.12	57.19
4	0.24	37.75	0.24	48.81	42.14	0.18	148.43	162.31	53.98	54.03
5	0.20	32.56	0.20	43.27	45.54					

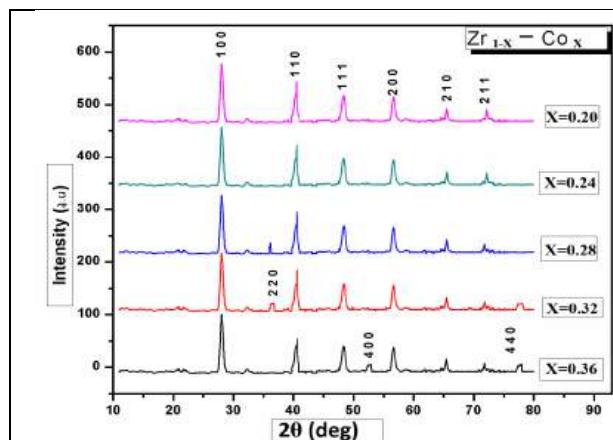
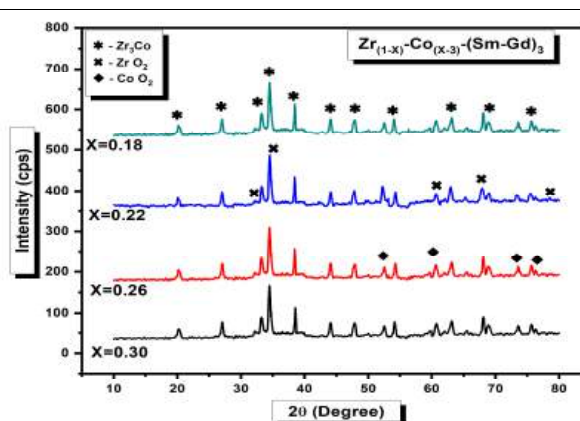


Fig.1: XRD patterns of (Zr-Co) series alloys

Fig 2: XRD patterns of (Zr_{1-x})-Co_(x-3)-RE₃ series alloys



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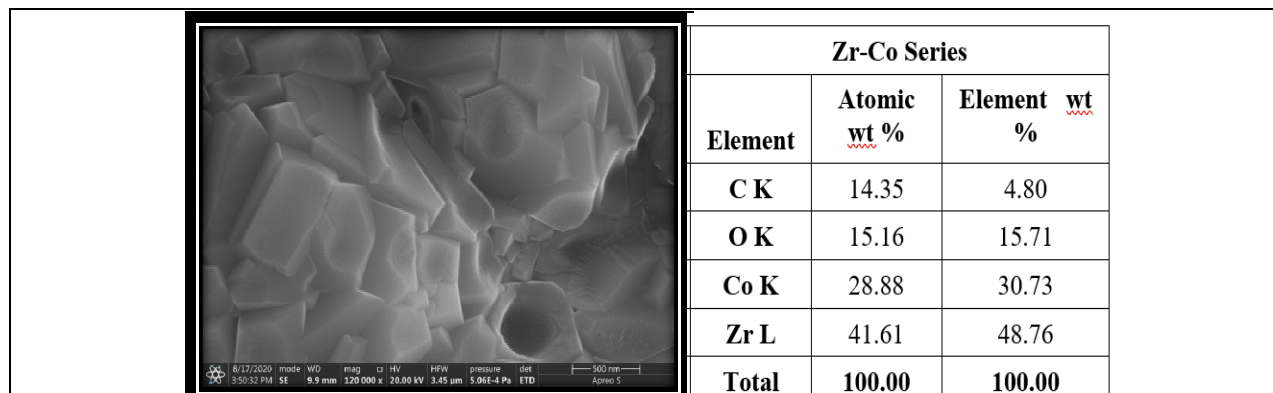


Fig. 3. Results of SEM micrograph and Elemental Concentration of (Zr-Co) NEG material.

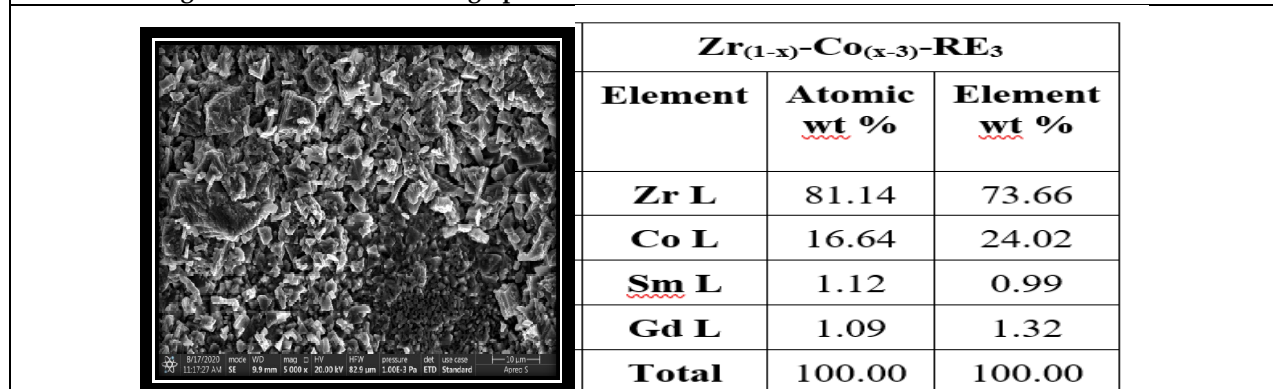


Fig. 4. Results of SEM micrograph and Elemental Concentration of (Zr-Co-RE) NEG material.

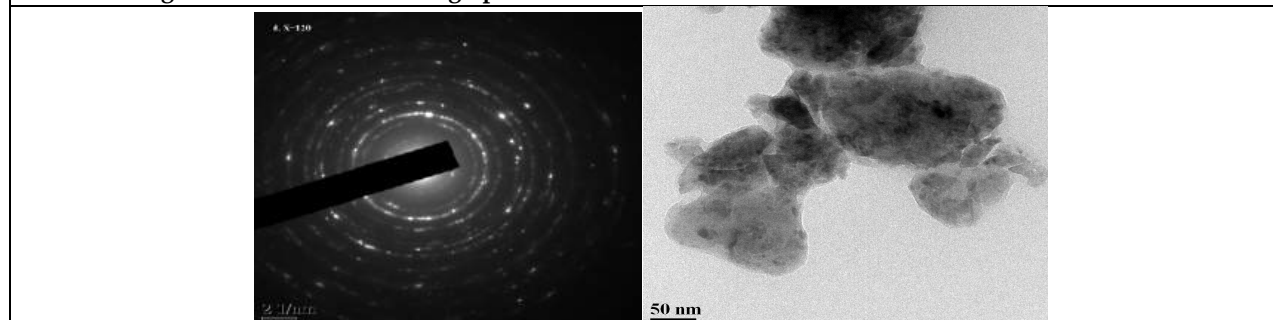


Fig. 6. TEM images of (Zr-Co)

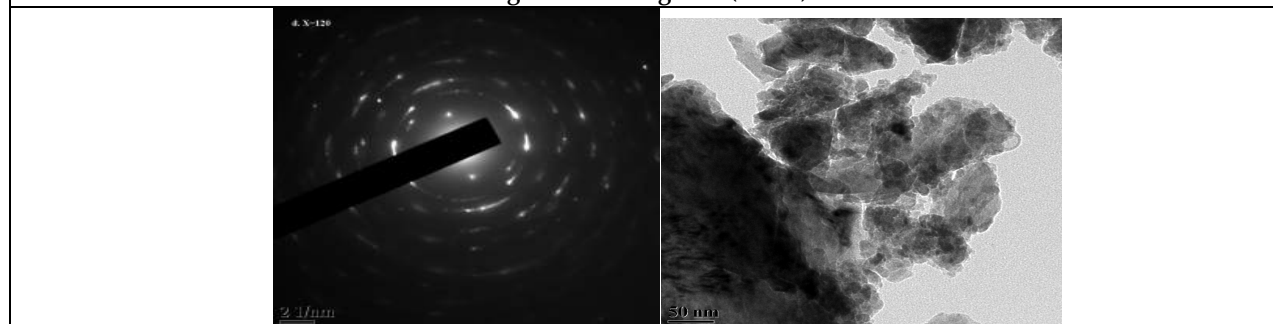


Fig. 6. TEM images of (Zr-Co-RE)





Enhanced Intrusion Detection Using Deep Learning: A Recurrent Neural Network-Based Approach (RNN-IDS)

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ABSTRACT

Intrusion detection important role in data defense and its main skill is to detect various attacks in neural network. It will explore how to a model depth-based intrusion detection and presents a deep learning approach to Recurrent neural linkage in intrusion detection (RNN-IDS). We also referred the activity of the model in two-class and various -class, as well as the effect of neurons and different topics on the performance of the model. Here, we compare it with previous training machine learning such as J48, (ANN) Artificial neural network, RF and support vector machine on test data. Experiments show that RNN-IDS is suitable for building high-level classification models and its performance is better than traditional classification models whether it is two-class or multi-class. The RNN-Intrusion detection system model improved accuracy of interruption identification

Keywords: Recurrent Neural Networks, Intrusion Detection, Machine Learning, Deep Learning.

INTRODUCTION

We live amongst a world where there is no limit to grow in any field, be it architecture or software, that is, there is no limit to growth. As technology advances every day, it brings new threats and vulnerabilities to organizations. In order to overcome these threats and vulnerabilities, Intrusion Detection Systems (IDS), which are security controls for computers and networks, have been introduced. It is responsible for all the activities that occur in the network. It





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determines all the suspicious patterns in the network and whether anyone is trying to hack the system or data, and also checks if there is any attack around the network. Traditional machine learning methods such as SVM, ANN, RF, KNN and Naive Bayes have performed well in accessing data, but they also have some limitations in terms of working. We introduce Recurrent Neural Networks (RNN) to improve the performance of IDS. Therefore, IDS model is introduced to detect the behavior of the network.

Intrusion Detection System

An organization that scans network connections for skeptical behavior and raises an alarm if it finds any is known as an intrusion prevention system (IDS). IDSs are software programs. It looks for any harmful activity on the network. Only by making a system or service susceptible can a breach obtain authorized access to it. An invader is the one who enters. When someone leaves some bugs and the intrusion detection system finds them, they are considered intruders. Confidentiality, integrity, and availability define access. To maintain confidentiality, data must be shielded from unwanted access. Integrity guarantees the accuracy and safety of information. Should the file be appropriately prepared, the user's capability will be shown. IDS is really focused on crime, but false positives are possible. Therefore, organizations need to be careful before installing IDS products. It can identify normal traffic on the network from abnormal traffic. IDS provide many benefits to organizations, such as identifying security incidents. IDS help detects attacks on the network perimeter so organizations can make changes to their security systems and implement better controls. IDS also help in identifying errors and faults in the network. This will help in assessing future risks. Recurrent Neural Networks (RNN)

There are some limitations in the feedstuff accelerative neural networks. They are:

- Cannot switch ongoing data
- Studies only current input
- Can't memorize previous inputs

These drawbacks can be rectified by using Persistent Neural Network (RNN). RNN can knob sequential data, accepting the current input data and memorizing previous inputs. Since RNN is having internal memory, it can memorize previous inputs.

The input process -x- takes input from the network and passes it to the intermediate process. The middle layer contains many hidden structures, each with its own function, weight, and bias. If the interval of the hidden process is not affected by the previous process, then there is no memory. In this case, we use RNN. Here, instead of creating multiple layers, it will create a hidden layer and loop in this layer as no of times as necessary.

The current state is calculated by the formula: $ht = f(ht-1, xt)$

Here ht is the current state, $ht-1$ is the previous state, xt is the input state

Now the hidden state calculation formula: $ht = \tanh(W_{hh} h_{t-1} + W_{hx}xt)$

Here, W_{hh} is the weight of the recurrent neuron. W_{hx} is the weight of the input neuron

The output formula: $yt = W_{hy} ht$

Among them, W_{hy} is the weight of the output layer

(LSTM)Long Short-Term Memory

Many changes have been made for solving the problem of incomplete information and search. Short-term trending (LSTM) is an example. LSTM remembers every experience the network sees, whether it is useful or not. It eventually forgets the useless information. Independently LSTM persistent fragment also sustains a direction called the "internal unit state" that explains the facts that the previous LSTM chose to store. This is done by introducing a series of functions called gates. LSTM has four different thresholds. They are:

Input gate (i): Indicates the various types of data to be written to the state unit. Gate (g): Is part of the input gate. Most of the data in LSTM ignores this and assumes it is in the input table. This gate layout is not very popular in this model. Although it is a good preparation to include it in the assembly of the LSTM cell.

Output Gate (o): Concludes whether the output is produced according to the state of the cell.



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LITERATURE SURVEY

This study analyzes the Kddcup - 99 and its updated version, nsl-kdd, for intrusion detection, classifying attacks into four types: Denial of Service (DoS), Probe, Remote to Local (R2L), and User to Root (U2R). The authors applied machine learning techniques like RF, CART, SVM, J48, and Naive Bayes to the dataset, assessing their performance [1]. RF was identified as the most accurate model. The study concluded that RF's high accuracy makes it ideal for intrusion detection. Thus, it was used as a feature selection method for improving classifier efficiency[2]. The NSL-KDD dataset has 41 features and was designed to eliminate redundant records from KDD 99, improving detection accuracy. ANN models were applied to train and test on this dataset, with different architectures and hidden layers being evaluated [3]. A trait selection method centered on Improvement Ratio (GR) was applied to enhance the model's accuracy while reducing irrelevant features. The ensemble of ANN and Bayesian Net outperformed the individual models, proving that combining classifiers can yield better results. By reducing the feature set, the study achieved higher classification accuracy with fewer inputs, making the system more efficient. [4] They applied a decision tree classifier to assess the effectiveness of the selected features and compared it with other feature selection methods like AR, CFS, IG, and GR. The results showed that reducing the number of features significantly improved the accuracy of the classifier. For example, with 22 features, the accuracy reached 88.794%, compared to 98.863% when using the full dataset. [5] The DLSTM model leveraged a feature selection algorithm based on information gain to reduce the feature vector, improving processing efficiency. The model achieved 88.51% accuracy on training data and 86.99% accuracy on test data. [6] The results showed that FFDNN-IG outperformed these models for both binary and multiclass classification tasks, achieving 89.37% accuracy on training data and 86.76% on test data. The study also found that the depth and number of neurons in the network significantly influenced the model's performance, highlighting the importance of network architecture in deep learning models. [7] The study highlights the effectiveness of the K-means clustering algorithm in classifying attacks. Moreover, the authors compared the performance of traditional algorithms like Support Vector Machines and Decision Trees with clustering methods [8]. The experiments demonstrated that RF outperforms other traditional classifiers like Decision Trees and Naive Bayes in accurately identifying attack types, making it an effective classifier for IDS. The model showed superior performance due to RF's ability to handle high-dimensional data and reduce over fitting by averaging the results from multiple decision trees. [9] By refining the feature selection and kernel choice, the experiment showed a significant reduction in training time and an increase in the attack detection rate. Additionally, the false positive rate (FPR) was minimized, making the SVM model more practical for real-time applications. [10] The MLP architecture allows the IDS to handle complex input patterns and dynamically adjust based on the training data. The results showed that the neural network-based IDS outperformed traditional methods in identifying intrusions while maintaining low false positive rates [11]. The LSTM model, optimized using the Nadam gradient descent optimizer, showed superior performance with a detection rate of 88.95% on training data, a precision of 89.69%, and an accuracy of 87.54%. The false alarm rate (FAR) was also significantly reduced to 9.98%, making it a reliable model for real-time intrusion detection. The LSTM's capability to capture longstanding dependences in chronological data makes it particularly effective.

Analysis

Existing System

Deep learning-based intrusion detection system introduces a deep learning method that uses recurrent neural network (RNN-IDS) to enhance detection. RNN-IDS entails of an input layer, a hidden coat, and an output layer. This IDS is trained and tested using the standard NSL-KDD dataset. The model is then compared with other machine learning methods based on previous analysis of benchmark data with conventional machine learning classifiers (such as RFs, multilayer perceptron's, support vector machines, naive Bayes). In addition, they studied the performance patterns in binary and multi-class classification, as well as the influence of neurons and different subjects on the recital patterns. The accuracy of this IDS is 74.4% on training data and 60.66% on testing data.





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Proposed System

Detection method using neural networks (RNN) is introduced. RNN has input, hidden and output. All computations are in hidden layers. NSL-KDD file is used in this project. It contains training materials and testing materials. In order to minimize the amount of residual data input, the response data should be processed first to eliminate unnecessary data. The target data should then be chosen using a neural network procedure. The RNN-IDS is then trained using this information by feeding it into a recurrent neural network. Lastly, testing was conducted using the NSL-KDD test data. The RNN-IDS standard offers a fresh approach to intrusion detection research while also increasing intrusion detection accuracy. The RNN-IDS is evaluated using the following values: accuracy and index.

Advantages of Proposed System

- The proposed system gave higher accuracies while detecting network intrusions than the existing systems.
- There is some sequence of steps for feature selection which are more accurate than the existing systems.
- Simple and Fast training procedures.
- RNN is used here which is more beneficial because there will be only one neuron that rotates throughout the entire system.

System Architecture

Show the diagram Figure.3

Dataset Description

There are some important problems in the configuration file that affect the operation of the system. It leads to a negative evaluation of the detection method. To solve these problems, NSL-KDD dataset is introduced. It contains the information in the entire KDD file. NSL-KDD has 41 features and 1 feature group. Training is done on the KDD training profile containing 22 types of attacks and testing is done on the KDD test profile containing 17 additional types of attacks.

Flow Diagram

Show the Figure 4

METHODOLOGY

Most organizations are under attack from both inside and outside. Attacks from OT(outside) the network can be easily deal by means of a firewall. However, attacks from confidential the network are not easy to deal with. Therefore, using intrusion prevention devices can accurately detect unexpected attacks in the network. This project presents an approach using deep learning techniques with recursive classes that outperform traditional machine learning techniques for data classification as attacks.

RESULTS AND ANALYSIS

Binary Classification

RNN-IDS model is used for dualistic classification such as normal and abnormal and five groups taxonomy such as Normal, DoS, R2L, U2R and Research. At the same time, comparative experiments are created to parallel with other machine knowledge methods. The performance of machine learning such as NB, J48, RF, ANN and SVM in binary classification is compared. 41-dimensional characteristics are mapped into 122-dimensional features in the binary classification studies. Thus, the archetypal RNN-IDS comprises 2 output nodes and 122 input nodes. There are 100 epochs in all. The number of hidden nodes is 20, 40, 60, 80,120 and 240, respectively, and the learning rates 0.01, 0.1, and 0.5, respectively, in order to obtain a better model to train. The accuracy is then observed on the NSL-KDD





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dataset. Various outcomes are attained, demonstrating the accuracy in relation to the number of buried protuberances and learning rate.

CONCLUSION

The RNN-IDS archetypal not only has good modeling aptitude for intervention sighting, in various classification tasks of NSL-KDD dataset, this ideal has achieved higher accuracy and detection than traditional classification methods such as J48, chance forest and SVM. This model can improve the accuracy of intrusion detection and the ability to determine the intrusion type. Future research will focus on using GPU acceleration to reduce the training time, prevent gradient collapse and loss, and study the proportionality of LSTM and bidirectional RNN systems in the field of intrusion detection. Compared with the results of models built by machine learning algorithms such as J48, RFs, support vector machines and Artificial neural networks (ANNs) the models built by deep neural networks using Hidden methods have better explanations. For this purpose, some deep learning methods have been studied and the use of interference detection procedures has been selected. Further tests will be carried out using a network connection (of the neural network type) and on the building's protection and access barriers.

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The Impact of Coconut Biodiesel on Diesel Engine Performance and Emission Characteristics: A Review

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ABSTRACT

Biodiesel has become a significant alternative to fossil fuels due to environmental concerns and the depletion of petroleum resources. Among various biodiesel feed stocks, coconut oil-based biodiesel, or Coconut Methyl Ester (CME), has gained attention, particularly in tropical regions. This review focuses on the effects of CME blended fuels on diesel engine performance and emissions, as revealed in recent studies. Coconut biodiesel blends, such as CB5 (5% CME, 95% diesel) and CB15 (15% CME, 85% diesel), were analyzed for their impact on parameters such as engine torque, brake power, specific fuel consumption, and emission characteristics (CO, NO_x, HC, and CO₂). The results show that biodiesel blends have a slight reduction in engine performance (torque and brake power) but improve fuel combustion and reduce harmful emissions. CO and HC emissions decreased with increasing biodiesel content, whereas NO_x and CO₂ emissions were found to increase due to higher oxygen content in the biodiesel. Despite some drawbacks, coconut biodiesel has demonstrated significant potential as a renewable energy source that can reduce environmental pollution and reliance on fossil fuels. The studies also indicate that CME can be used in existing diesel engines without major modifications, making it a practical alternative for countries with abundant coconut resources. This review synthesizes findings from research conducted between 2020 and 2024, providing insights into the current state of coconut biodiesel research and highlighting the potential for future development.

Keywords: Coconut Methyl Ester (CME), blends, emission characteristics, Engine performance, Hydrocarbons





INTRODUCTION

The global energy crisis and concerns over environmental degradation have spurred the search for alternative fuels to replace petroleum-based products. Among the options, biodiesel[1] has emerged as a promising solution due to its renewable nature, reduced emissions, and compatibility with existing diesel engines. Biodiesel can be derived from various feedstocks, including vegetable oils and animal fats[2,3]. In tropical regions, coconut oil has been identified as an ideal feedstock due to its local availability and favorable properties for biodiesel production[4]. Coconut Methyl Ester (CME) is produced through the transesterification[5] of coconut oil and has been widely studied for its use in diesel engines. CME offers several advantages, such as a high cetane number, better lubricity, and lower emissions compared to fossil diesel. However, like other biodiesels, it also has some limitations, such as a lower calorific value and higher viscosity, which can impact engine performance. This review examines recent studies on the performance and emission characteristics of diesel engines using CME-diesel blends, focusing on key performance indicators such as torque, brake power, specific fuel consumption (SFC), and emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x), and carbon dioxide (CO₂). The goal is to provide a comprehensive understanding of how coconut biodiesel can contribute to cleaner energy solutions while maintaining engine efficiency.

METHODOLOGY

The studies reviewed in this article[1] typically involve blending coconut biodiesel with conventional diesel fuel in varying proportions. Common blends include CB5 (5% CME, 95% diesel) and CB15 (15% CME, 85% diesel), although other blends have also been investigated. The performance and emissions tests are usually conducted using a four-stroke, single-cylinder, direct injection diesel engine represented in figure 1. The engine is mounted on a test bed and coupled to a dynamometer for measuring torque and brake power. Engine performance is evaluated at different engine speeds, ranging from 1500 to 2400 rpm. Specific fuel consumption (SFC) is measured to assess fuel efficiency[1]. For emissions testing, exhaust gases are analyzed using portable gas analyzers that measure CO, HC, NO_x, and CO₂ levels. The experiments are conducted at two throttle positions: 100% (full load) and 80% (partial load) to simulate real-world operating conditions. Noise levels are also measured in some studies using sound level meters placed around the engine test bed. This parameter is important because diesel engines are known to produce significant noise, which can impact the overall usability of the engine in different applications. The methodologies across the studies maintain a consistent approach, allowing for a comparative analysis of the effects of CME on engine performance and emissions[6-13].

RESULTS AND DISCUSSION

Engine Performance

Torque and Brake Power: Studies have shown that CME blends result in a slight reduction in torque and brake power compared to diesel fuel. This reduction is attributed to the lower calorific value of biodiesel, which means that less energy is available for combustion. The average torque reduction for CB5 was around 0.7%, while CB15 showed a reduction of about 2.6%. Similarly, brake power decreased by approximately 0.7% for CB5 and 2.6% for CB15 across the studies.

Specific Fuel Consumption (SFC): The SFC for biodiesel blends tends to be higher than for diesel fuel due to the lower energy content of biodiesel. For the same energy output, the engine consumes more fuel when running on biodiesel. On average, CB5 exhibited a 0.5% increase in SFC, while CB15 showed a 2.1% increase.

Emissions:

Carbon Monoxide (CO): CO emissions were consistently lower for CME blends compared to diesel. The additional oxygen content in CME helps achieve more complete combustion, reducing the amount of CO produced. CB5 showed a reduction in CO emissions of about 13%, while CB15 showed a reduction of up to 21%.



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Hydrocarbons (HC): Like CO emissions, HC emissions were also reduced with CME blends. The oxygenated nature of biodiesel leads to more efficient combustion, leaving fewer unburned hydrocarbons. Studies reported reductions in HC emissions of up to 22% for CB15.

Nitrogen Oxides (NOx): NOx emissions, however, were found to increase with the use of CME. The higher combustion temperatures caused by the oxygen in biodiesel lead to greater NOx formation. CB5 showed a 1.4% increase in NOx, while CB15 exhibited an increase of up to 3.2%.

Carbon Dioxide (CO2): CO2 emissions were higher for biodiesel blends due to the more complete combustion of the fuel. This is generally seen as a positive outcome, as CO2 is less harmful than other pollutants such as CO or HC. CB15 showed an increase in CO2 emissions of around 4.6%.

Noise Emissions

Noise levels were found to be slightly lower for CME blends compared to diesel. The higher cetane number and better lubricity of CME help reduce engine knock and combustion noise. Studies showed that CB5 and CB15 reduced noise levels by 2-3 dB compared to diesel. The reduction in torque and brake power observed in the studies is consistent with the lower energy content of biodiesel compared to diesel. However, the decrease is relatively small, indicating that CME can still provide sufficient performance for most diesel engine applications without requiring significant engine modifications. The increase in specific fuel consumption is also expected due to the lower calorific value of biodiesel. While this may raise concerns about fuel economy, the environmental benefits of biodiesel, particularly in terms of reduced emissions, often outweigh the slight decrease in fuel efficiency.

The reduction in CO and HC emissions is one of the most significant benefits of using CME. The oxygen content in biodiesel improves combustion efficiency, leading to fewer incomplete combustion products. This makes CME an attractive option for reducing harmful pollutants in diesel engine exhaust. The increase in NOx emissions is a well-documented issue with biodiesel. While biodiesel reduces other emissions, its tendency to increase NOx remains a challenge. Future research could focus on optimizing engine settings, such as injection timing and exhaust gas recirculation (EGR), to mitigate this effect. Noise reduction is another benefit of CME blends. Diesel engines are notorious for their noise, and biodiesel's higher cetane number helps reduce engine knock, resulting in a quieter operation. This could make CME a more attractive option for applications where noise is a concern, such as in urban areas.

CONCLUSION

Coconut biodiesel (CME) offers a promising alternative to conventional diesel fuel, particularly in tropical regions where coconut oil is readily available. The studies reviewed in this article demonstrate that CME blends can be used in existing diesel engines without major modifications while providing significant environmental benefits. Although CME blends result in a slight reduction in engine performance, this is offset by the reductions in harmful emissions such as CO and HC. The increase in NOx emissions remains a challenge, but this could be addressed through engine tuning and emission control technologies. Overall, CME has the potential to reduce the environmental impact of diesel engines while promoting the use of renewable energy sources. As research into biodiesel continues, further improvements in performance and emissions could make CME a key player in the transition to cleaner energy.

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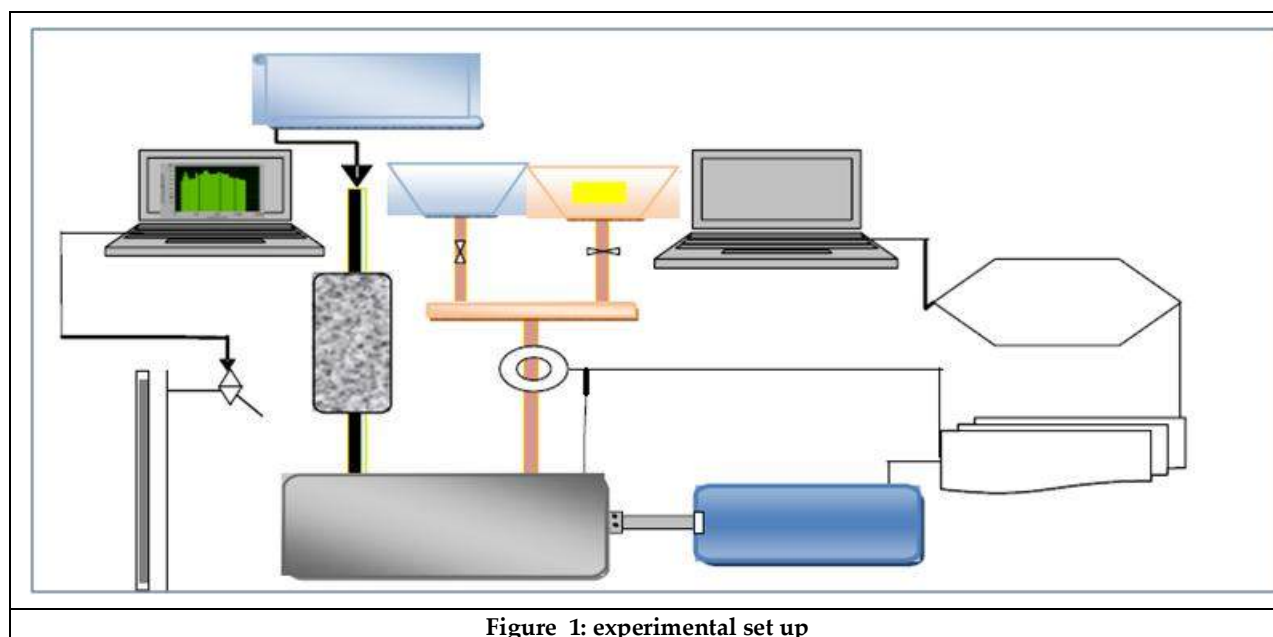


Figure 1: experimental set up





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Table 1. Test engine technical specifications

Engine type		Four stroke DI diesel engine
Number of cylinders		One
Aspiration		Natural aspiration
Cylinder bore x stroke	mm	92 x 96
Displacement	L	0.638
Compression ratio		17.7
Max. engine speed	rpm	2400
Max. power	kW	7.7
Injection timing	deg.	bTDC 17.0
Injection pressure	kg/cm ²	200

Table 2. Some of the important tested fuel properties

Parameters	CB5	CB15	DF
Kinematic viscosity @ 40 °C (cSt)	3.344	3.425	3.317
Heating value (MJ/kg)	45.407	44.838	45.547
Density @ 40 °C (gm/cm ³)	0.823	0.825	0.822
Flash point (°C)	83	86	78
Cetane number	51.5	53.4	51

Figure 2:Engine Technical specifications





YouTube as a Resource in Elevating English Language Learning Skills - Listening & Speaking

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ABSTRACT

This research is conducted using questionnaire data, which shows the achievement of pupil learning issues in the material "The Power of YouTube to Improve Listening and Speaking Skills." Experimenters conducted action research aimed at perfecting pupil learning issues. The objects to be achieved in this research include 1.) to determine the strength of YouTube in the English literacy process in perfecting listening and speaking skills, and 2.) to determine the increase in pupil learning issues by using YouTube. This research was conducted on B.Tech students of Centurion University of Technology and Management. This research measures how strong the part of YouTube is in the tutoring and literacy process. The research results show that the respondents agree that YouTube can improve listening and speaking skills with a variety of different content that the respondents access. With this literacy system, scholars get further intriguing literacy and can improve good learning issues that are not boring and easy for scholars to accept. From this research, it's recommended for learners to use literacy styles using YouTube. The results of the study demonstrated that the speaking abilities improved. Nevertheless, the experimental group showed more improvement in speaking skills compared to the traditional learning. The experimental group showed significant improvement in delivery and language use when utilizing YouTube videos in speaking classes. This paper aims to explore the power of YouTube in perfecting listening and speaking skills and its implications as a precious resource for language learners.

Keywords: YouTube, English literacy, language tutoring, traditional learning

INTRODUCTION

Language is an important channel of communication through which we partake in our personal and professional involvement (Nishanthi, 2018) [1]. Learning English will make it easier to get information from all over the world.



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And it is veritably important because English has become a transnational language. An important aspect of learning English is listening. Learners who speak English as a Foreign Language (EEFL) need to hear English every day if they want to communicate (Darti & Asmawati, 2017) [2]. Listening and speaking skills have a significant part in learning English because receiving language input is a major skill that's important when learning a language. There are numerous ways to improve skills in English, one of which is using online applications as a medium for listening to learning materials, thereby making it easier for people who want to learn English. These days, numerous applications are easily accessible to all and one of the media that numerous people use to improve their listening and speaking skills is YouTube. YouTube is extensively used as a literacy medium because it's easy to use and has different content similar to music, English exchanges, cartoons, learning robustness, and learning videos. Its different content makes it easy for scholars to choose the right literacy media for them and not get worn out. Its appearance is also seductive and easy to use. Mukarrama *et al.* (2015) [3] stated that listening as an open skill is veritably important to develop scholars' language capability and performance.

According to Brünner (2016) [4] YouTube is the most popular platform among scholars. It's a website where YouTubers may detect and submit videos related to their interests. Likewise, it's a videotape library service that's cost free for all who wants to learn and can be used to self development and up-skill language literacy. (Latifah & Prastowo, 2020) [5]. In fact, using videotape to practice listening and speaking skills may give scholars a clear perception of how the language is employed, as well as familiarity in native speakers' accent, voices and conduct. YouTube has really revolutionized the way we consume media and information. While it's extensively known as a platform for entertainment, it also holds significant potential for educational purposes, particularly in perfecting listening skills. Through its vast collection of videos gauging colorful stripes and subjects, YouTube offers a unique occasion for language learners to enhance their listening capacities. Likewise, learning media can also snare learners' interest in the process of literacy, making it more meaningful (Prayuno & Mardianto, 2020; Rosmiati & Lestari, 2021) [6]. In this research, a YouTube application was used to improve English listening and speaking skills. YouTube serves as a medium for discussion, question and answer, literacy, listening, searching, viewing, and participating in videos from the world online. This media is considered to give wider information that can be penetrated anytime, anywhere, and can be viewed, used, and relearned by people. YouTube can give scholars and faculty freedom of expression, unite in the world of education, and gain precious experience in perfecting the quality of education. It is found that the decision-making of EFL teachers to use YouTube Vlogs in teaching English vocabulary and expressions and genre-based text in the classroom was a positive step. These were the beliefs towards the implication of YouTube videos in language learning and teaching, the pedagogical content knowledge and the knowledge of students' characteristics and learning style, and the thinking towards the nature of learning using YouTube Vlog.

YouTube platform is an audio-visual aid that can help learners improve their auditory and speech and coining new words. (Visual). (Gerbier 2017) [7] stated that reading a textbook while listening can encourage the pupil's interest in fastening on the course material. Likewise, learning a language will be easy to understand if the school teacher uses the correct tools. In short, a good explanation with suitable instruments will help the schoolteacher and pupil to be closer and concentrate on the material, primarily in listening tasks. The YouTube list- IELTS, Podcast, Cambridge, TED talks etc bettered scholars' listening and speaking skills. According to the data, the majority of scholars believe that YouTube helps them improve their listening and speaking skills. Individuals may come more motivated to learn English as a result of this app because of the ease with which they can use YouTube to learn. This research was made by the faculty of Basic Science and Humanities on semester I pupils at Centurion University of Technology and Management. The authors focused on how students are progressing academically in the field of proficiency in the English language. Additionally, the authors gave students questionnaires to examine how YouTube affects the growth of their listening and speaking skills abilities. This research population was created for professional students because YouTube can develop hearing to pronounce good words and sentences. The fact that YouTube might improve hearing to pronounce words and sentences correctly was admitted. The researcher deduced from a few of the aforementioned publications that employing YouTube can help pupils do better in class when it comes to listening and speaking skills.





METHOD

The purpose of the data source for this study is to demonstrate how effective YouTube is.

Data collection was carried out with several questions, some of which are as follows:

1. How effective do you find subtitles or captions on YouTube videos for improving comprehension?
2. What types of YouTube channels or creators do you follow specifically for language learning?
3. Do you prefer watching formal educational content or informal conversational videos? Why?
4. How effective do you find subtitles or captions on YouTube videos for improving comprehension?
5. What types of YouTube channels or creators do you follow specifically for language learning?
6. Have you ever faced challenges with the speed of speech in YouTube videos? How do you manage that?

RESULTS AND DISCUSSIONS

Utilization of YouTube Content to Learn Listening Skills: these results reveal the habits of first-semester students in using YouTube to improve their listening and speaking skills and the kind of content they often access to. The results showed that 10 out of 10 students who are active YouTube users stated that YouTube helped them improve their listening and speaking skills. Based on the response obtained from the respondent, it shows that he uses YouTube to read and listen to songs with lyrics and translations. It turns out that this is not only done by one respondent but by nine other respondents. This means that 10 out of 10 students have the habit of accessing songs via YouTube to help them improve their listening and speaking skills. However, not only to access songs, other respondents have the habit of learning to use YouTube by watching podcast videos, news, short stories, motivational videos, educational content, and reality shows.

DISCUSSION

The results set up in this study can be epitomized. First of all, our research findings show that English language learners are familiar with English listening and speaking skills courses where the skills can be tested from social media, including YouTube. It is believed that the application of the YouTube platform in language literacy may reduce stress because the learners will see learning a new language as an enjoyable and educational exertion. Its use infiltrates every aspect of listening skills learning. In addition, English language learners feel familiar with YouTube as a concept and as a popular point that can give all kinds of educational videos they need, similar to listening to music, podcasts, foreign pictures, etc. This can be used by them to study and learn. They can use this to learn and also test themselves. Using videotape as medium of literacy may enhance English language scholars' skills, particularly supposition, and agree on their utility in literacy.

CONCLUSION

Based on the data that has been provided and on the findings of the research that has been done, it turns out that there are positive effects and ways to enhance English language proficiency while using the YouTube app. Additionally, with its seriousness, YouTube will be used to its fullest potential to help improve hearing. Other strategies that will be added include applying new vocabulary in everyday situations, writing down challenging words so that you can remember them later, and paying attention to pronunciations so that you become accustomed to using them. Instructors may find it simpler to teach when they use YouTube. Instructors do not need to raise their voice to create an effective learning environment during lessons. In crowded classrooms, it can be challenging for students to hear the instructor or one another. These difficulties can lead to a lack of motivation to engage as attentive listeners. There's no need to speak loudly to foster a productive learning atmosphere during lessons. In busy classrooms, students may struggle to hear the teacher or their peers, and these challenges can diminish their motivation to be focused listeners.





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Impact of National Educational Policy on Engineering Education in Indian Universities (2021-2024): Case Studies

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ABSTRACT

The National Education Policy (NEP) 2020, introduced by the Government of India, aims to transform the educational landscape of the country. This article explores the impact of NEP on engineering education in Indian universities from 2021 to 2024, with a focus on case studies from premier institutions such as IIT Madras, Visvesvaraya Technological University (VTU), and Manipal Academy of Higher Education (MAHE). The NEP's emphasis on multidisciplinary learning, research, industry collaboration, and digital education has brought about substantial changes in the engineering education framework. The study reveals that engineering institutions have adopted a more flexible and interdisciplinary approach, integrating subjects from humanities, management, and social sciences to produce well-rounded graduates. Research output has significantly increased, with universities establishing dedicated research centers and enhancing collaborations with industries and international partners. Additionally, the NEP's push for skill development, vocational training, and digital learning tools has improved employability and access to quality education. The article employs a mixed-method approach, combining quantitative data analysis with qualitative insights, to assess the impact of NEP on engineering education. Key metrics such as the number of multidisciplinary courses, industry partnerships, research projects, employment rates, and international collaborations were examined. The findings suggest that NEP 2020 has been instrumental in reshaping engineering education, making it more aligned with the



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demands of the modern world. This article concludes that NEP's influence has significantly improved the quality, flexibility, and global competitiveness of engineering education in India.

Keywords: NEP, VTU, MAHE, research

INTRODUCTION

The Indian education system has undergone numerous reforms over the years, but the introduction of the National Education Policy (NEP) 2020 marks a pivotal change, particularly in the context of higher education. NEP 2020 is a comprehensive policy that aims to transform India's education sector by promoting holistic, multidisciplinary, and flexible learning environments. Engineering education, which plays a crucial role in India's technological and industrial growth, has seen a remarkable transformation in the period from 2021 to 2024 due to the implementation of NEP 2020.

Objectives of NEP 2020 and Relevance to Engineering Education

NEP 2020 seeks to break down the silos of traditional education by promoting multidisciplinary studies, research, and industry collaboration. For engineering education, this means integrating humanities, social sciences, and management subjects into the core curriculum. The policy also emphasizes experiential learning, internships, digital education, and global exposure, making Indian engineering graduates more versatile and employable. Engineering universities across India have begun restructuring their curriculum and introducing innovative teaching methods to align with NEP's objectives. This article examines the effects of NEP 2020 on engineering education in Indian universities, with a focus on three key case studies: IIT Madras, VTU, and MAHE. These institutions provide insights into how the policy has shaped different aspects of engineering education, including curriculum design, research output, industry engagement, and digital learning.

NEP 2020's Influence on Key Aspects of Engineering Education

Multidisciplinary Approach: Traditionally, engineering education in India has been highly specialized, but NEP 2020 encourages the integration of diverse subjects, fostering creativity and problem-solving skills. Universities are now offering minors in economics, psychology, and management, allowing students to develop a more comprehensive skill set.

Enhanced Research and Innovation: NEP 2020 emphasizes research as a cornerstone of higher education, leading to increased funding, establishment of research centers, and collaboration with industries. Engineering institutions are focusing more on emerging fields like artificial intelligence, robotics, renewable energy, and sustainable technologies.

Industry Collaboration and Internship Opportunities: The policy encourages stronger ties between academia and industry, resulting in more internships, hands-on projects, and job placements. This has bridged the gap between theoretical knowledge and practical application, enhancing students' readiness for the job market.

Digital and Online Learning: The COVID-19 pandemic accelerated the adoption of digital education, and NEP 2020 has further catalyzed this shift. Universities are incorporating online courses, e-learning platforms, and blended learning methods to provide more accessible and flexible education.

Skill Development and Vocational Training: To make engineering education more practical and relevant, NEP 2020 encourages vocational training and skill development courses. This approach prepares students for a dynamic job market and enhances their employability.

METHODOLOGY

The study adopts a mixed-method research approach, combining quantitative data analysis with qualitative insights. The research focuses on three case studies: IIT Madras, VTU, and MAHE, which represent diverse geographical, institutional, and academic contexts in India.



Sudheer Choudari *et al.*,**Data Collection**

Quantitative Data: Statistical data from university reports, government publications, and research papers from 2021 to 2024 were collected. Key metrics such as the number of multidisciplinary courses, industry partnerships, research projects, online courses, and employment rates were analyzed.

Qualitative Data: Interviews with faculty, administrators, and students, along with reports from university websites and media sources, provided qualitative insights.

Data Analysis

- Quantitative data were analyzed using statistical tools to identify trends and changes over time.
- Qualitative data were thematically analyzed to understand the perceptions and experiences of stakeholders regarding the impact of NEP 2020.

RESULTS

Case Study 1: IIT Madras Table 1: Key Metrics at IIT Madras (2021-2024)

Case Study 2: VTU Table 2: VTU's Implementation of NEP (2021-2024)

Case Study 3: MAHE Table 3: Research and International Collaboration at MAHE (2021-2024)

CONCLUSIONS

The NEP 2020 has had a transformative impact on engineering education in Indian universities from 2021 to 2024. The adoption of multidisciplinary approaches, emphasis on research, industry collaboration, and digital learning has redefined the educational landscape, making it more holistic and future-ready. The integration of practical skills, vocational training, and enhanced international collaborations has improved the employability and global competitiveness of Indian engineering graduates. The case studies demonstrate that NEP 2020 has successfully initiated a paradigm shift, and its continued implementation is likely to propel India's engineering education to new heights.

Table 1: Key Metrics at IIT Madras (2021-2024)

Metric	2021	2022	2023	2024
Multidisciplinary courses offered	10	15	25	30
Industry collaborations	50	70	90	110
Funded research projects	100	130	170	200

Table 2: VTU's Implementation of NEP (2021-2024)

Metric	2021	2022	2023	2024
Vocational course enrollment	300	500	800	1200
Online courses offered	20	35	50	70
Graduate employment rate (%)	60%	65%	70%	75%

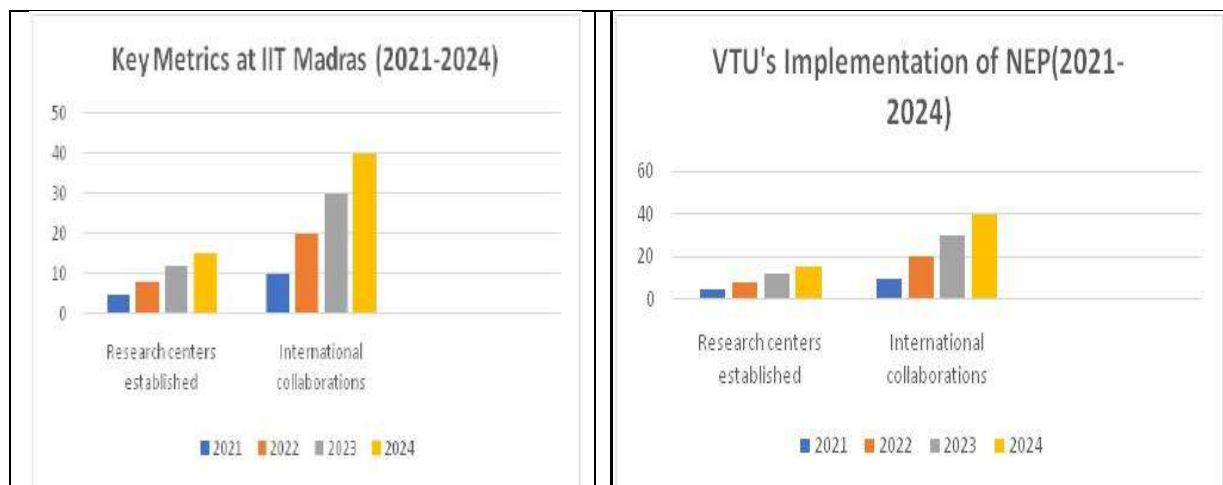
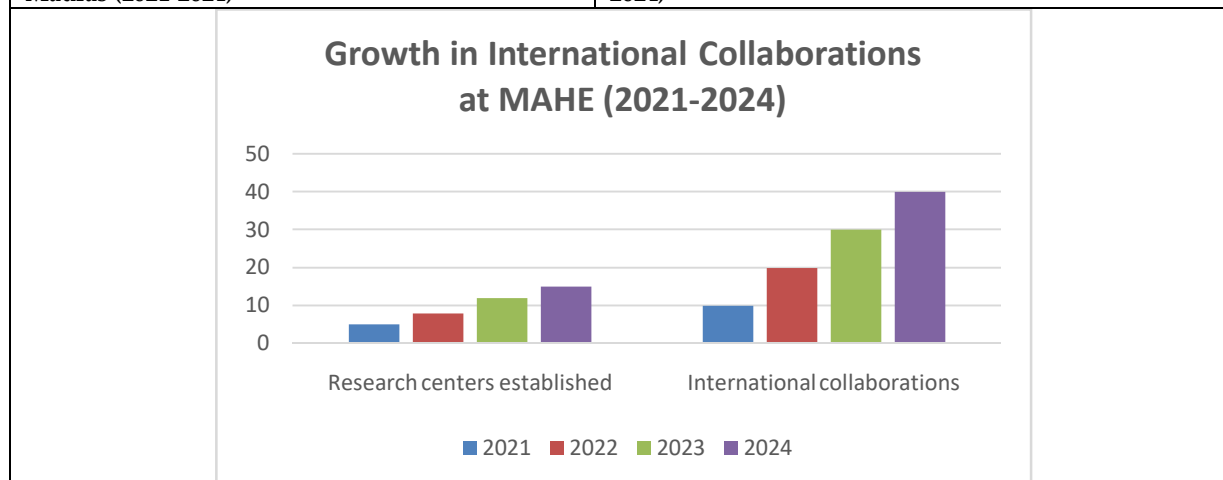
Table 3: Research and International Collaboration at MAHE (2021-2024)

Metric	2021	2022	2023	2024
Research centers established	5	8	12	15
International collaborations	10	20	30	40





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**Figure 1 Growth in Research Projects at IIT Madras (2021-2024)****Figure 2: Employment Rate of VTU Graduates (2021-2024)****Figure 3: Growth in International Collaborations at MAHE (2021-2024)**



The Contribution of Physical Activity to the Prevention and Management of Various Health Disorders

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ABSTRACT

Physical activity is fundamental to public health and is essential in the prevention and management of chronic diseases. This article offers an in-depth examination of the importance of physical activity, bolstered by statistical evidence from various research studies. We explore its effects on conditions such as cardiovascular disease, type 2 diabetes, obesity, and mental health issues, emphasizing the mechanisms through which physical activity delivers its advantages. Additionally, this article addresses the obstacles to engaging in physical activity, strategies for encouraging participation, and the implications for public health initiatives.

Keywords: Physical Activity, Disease Prevention, Chronic Diseases, Cardiovascular Health, Type 2 Diabetes, Mental Health, Exercise, Public Health Policies

INTRODUCTION

Engaging in physical activity involves any movement that demands energy and is vital for preserving general health. According to the World Health Organization (WHO), it is recommended that adults partake in no less than 150 minutes of moderate-intensity aerobic exercise each week. Despite this guidance, a significant number of individuals do not meet these recommendations, resulting in a rise in the incidence of chronic diseases. This article aims to deliver a comprehensive analysis of the importance of physical activity in disease prevention and management, backed by statistical assessments and data.





Study Needs

The escalating rates of chronic diseases across the globe, including cardiovascular conditions, type 2 diabetes, obesity, and mental health disorders, represent a significant public health dilemma. The World Health Organization (WHO) states that non-communicable diseases (NCDs) lead to 71% of global deaths, highlighting the imperative for effective preventive measures. Recent studies have identified lifestyle factors, particularly a lack of physical activity, as major contributors to the increasing rates of these diseases. Approximately 27.5% of adults worldwide fail to meet the recommended physical activity levels, which correlates with various adverse health outcomes. Additionally, the ongoing effects of urbanization, technological progress, and evolving social norms necessitate a thorough understanding of the obstacles to physical activity in order to create effective interventions.

Study Purpose

The main aim of this study is to thoroughly investigate the significance of physical activity in the prevention and management of chronic diseases. Through a review of existing literature and the presentation of statistical data, this study seeks to accomplish the following objectives:

Evaluate the Role of Physical Activity: Analyze the importance of habitual physical exercise in both the prevention and treatment of chronic diseases, especially highlighting its influence on cardiovascular health, type 2 diabetes, obesity, and mental health issues.

Identify Mechanisms of Benefit: Investigate the physiological and psychological processes by which physical activity provides health benefits, including enhancements in cardiovascular health, metabolic function, and mental wellness.

Examine Participation Barriers: Explore the individual, environmental, and societal factors that impede physical activity engagement among diverse populations, offering insights into the challenges encountered in meeting recommended activity levels.

Propose Promotion Strategies: Create actionable strategies and interventions to enhance physical activity at the individual, community, and policy levels, with the goal of boosting participation rates and enhancing public health outcomes.

Guide Public Health Policies: Offer evidence-driven recommendations for public health policies that advocate for and facilitate physical activity as an essential element in the prevention and management of chronic diseases.

Through these objectives, the study aims to underscore the significance of physical activity as a crucial factor in health promotion and disease prevention, ultimately leading to better health outcomes and a decrease in the prevalence of chronic diseases.

Epidemiology of Physical Inactivity

Global Trends

A 2020 report by the World Health Organization indicated that approximately 27.5% of adults globally fail to participate in adequate physical activity, resulting in roughly 3.2 million deaths annually due to inactivity-related diseases (WHO, 2020). Additionally, a systematic review conducted by Guthold *et al.* (2018) emphasized that physical inactivity is especially common in high-income countries, where sedentary lifestyles are more frequent.

Impact on Disease Incidence

Cardiovascular Disease

Research indicates that insufficient physical activity significantly contributes to the risk of cardiovascular disease (CVD). A meta-analysis of 33 studies published in *Circulation* revealed that individuals engaging in regular physical activity experience a 30-40% lower risk of developing CVD (Kyu *et al.*, 2016).

Type 2 Diabetes

In a cohort study by Hu *et al.* (2001) with over 100,000 participants, it was determined that individuals who consistently participated in physical activity had a 30-50% lower likelihood of developing type 2 diabetes than those who led a sedentary lifestyle. This observation was reinforced by a systematic review that demonstrated a dose-response relationship linking physical activity levels to diabetes risk (Hirsch *et al.*, 2017).



**Binoda Kumar Nayak and Vimal Kar****Obesity**

Findings from the National Health and Nutrition Examination Survey (NHANES) indicated that increased physical activity correlates with lower body mass index (BMI) and a decreased prevalence of obesity. The survey revealed that adults adhering to physical activity guidelines exhibited a significantly lower prevalence of obesity (CDC, 2018).

Mechanisms of Action**Physiological Mechanisms****Cardiovascular Health**

Engaging in regular physical activity fortifies the heart and enhances blood circulation. Research published in the Journal of the American College of Cardiology indicated that participating in at least 150 minutes of moderate-intensity exercise weekly resulted in a notable decrease in systolic blood pressure (SBP) by an average of 5-10 mmHg (Cornelissen & Smart, 2013).

Metabolism

Exercise improves insulin sensitivity and glucose metabolism, thereby lowering the risk of developing type 2 diabetes. A study conducted by Boule *et al.* (2005) revealed that individuals with prediabetes who maintained a routine of regular exercise experienced a 58% decrease in the likelihood of progressing to diabetes over a three-year period.

Psychological Mechanisms**Mood Enhancement**

Physical activity triggers the release of endorphins and various neurotransmitters, which enhances mood and alleviates symptoms of depression and anxiety. A meta-analysis by Rebar *et al.* (2015) demonstrated that exercise effectively reduces depressive symptoms, with moderate-intensity workouts yielding the most pronounced benefits.

Cognitive Function

Regular physical activity is linked to enhanced cognitive abilities and a diminished risk of dementia. A study focusing on older adults found that those who participated in consistent physical activity had a 35-40% lower risk of experiencing cognitive decline (Smith *et al.*, 2010).

Physical Activity in Disease Prevention**Cardiovascular Disease**

A thorough review featured in Heart (2019) established that engaging in moderate-intensity exercise significantly lowers the risk of cardiovascular disease (CVD) by enhancing various risk factors, including blood pressure, lipid profiles, and body weight. The Framingham Heart Study revealed that individuals who consistently participated in physical activity experienced a 50% reduction in heart disease risk compared to those who led a sedentary lifestyle (D'Agostino *et al.*, 2008).

Type 2 Diabetes

Engaging in consistent physical activity is crucial for the prevention of type 2 diabetes. The findings from the Diabetes Prevention Program (DPP) indicated that modifications in lifestyle, especially the enhancement of physical activity levels, led to a 58% reduction in the occurrence of diabetes within a three-year timeframe (Diabetes Prevention Program Research Group, 2002).

Obesity

According to the Centers for Disease Control and Prevention (CDC), engaging in physical activity is vital for achieving and maintaining a healthy weight, as well as for fighting obesity. Analysis from the Behavioral Risk Factor Surveillance System (BRFSS) reveals that adults who consistently partake in physical activity demonstrate a markedly lower rate of obesity than their sedentary counterparts (CDC, 2021).

Cancer Prevention

Recent studies indicate that consistent physical activity may lower the risk of developing certain types of cancer. The American Cancer Society reports that individuals who are physically active have a reduced risk of breast and colon cancer, with a meta-analysis revealing a 24% decrease in breast cancer risk and a 21% decrease in colon cancer risk among those adhering to physical activity guidelines (WCRF/AICR, 2018).



**Binoda Kumar Nayak and Vimal Kar****Mental Health**

Physical activity is acknowledged for its beneficial effects on mental health. Research published in JAMA Psychiatry (2018) found that individuals who regularly engaged in physical activity experienced a lower incidence of depression, with each additional hour of activity correlating with a 5-10% reduction in the risk of depression.

Physical Activity in Disease Management**Rehabilitation Programs**

Well-structured exercise regimens play a crucial role in the rehabilitation of various medical conditions. Evidence from cardiac rehabilitation initiatives indicates significant improvements in patient outcomes following heart disease, with a meta-analysis revealing a 30% decrease in mortality rates among participants compared to those who did not participate (Sagar *et al.*, 2015).

Chronic Disease Management**Diabetes Management**

Engaging in regular physical activity is essential for effective diabetes management. Research involving adults with type 2 diabetes demonstrated that those who maintained a consistent exercise routine achieved better glycemic control, with reductions in HbA1c levels averaging between 0.5% and 1% (Colberg *et al.*, 2016).

Hypertension Management

Regular physical activity is beneficial for lowering blood pressure and enhancing overall cardiovascular health. The American Heart Association endorses consistent exercise as a fundamental approach to managing hypertension, with research indicating that moderate-intensity workouts can reduce systolic blood pressure by 5-7 mmHg (Whelton *et al.*, 2018).

Chronic Pain Conditions

Exercise has proven to be an effective strategy for managing chronic pain. A review published in Pain Medicine (2018) found that exercise therapy significantly alleviates pain and enhances functionality in individuals suffering from chronic pain, particularly in conditions like osteoarthritis and fibromyalgia.

Barriers to Physical Activity**Individual Barriers**

Lack of Motivation: According to a survey by the CDC, 29% of adults identified a lack of interest or motivation as a significant obstacle to engaging in physical activity.

Time Constraints: A notable 36% of respondents reported that time limitations were a major barrier to maintaining a regular exercise routine (CDC, 2019).

Environmental Barriers

Access to Facilities: Insufficient access to safe and affordable exercise spaces can discourage individuals from being physically active. Research indicates that those residing in areas with parks and recreational facilities are more likely to participate in physical activities (Gordon-Larsen *et al.*, 2006).

Societal Barriers

Cultural Attitudes: Cultural views regarding exercise and health can significantly affect individuals' readiness to engage in physical activity. Surveys reveal that cultural beliefs surrounding body image and exercise can impact participation levels (Sallis *et al.*, 2016).

Socioeconomic Factors: Financial limitations may restrict access to fitness resources, posing challenges for certain populations in maintaining regular exercise habits.

Strategies for Encouraging Physical Activity**Community Health Initiatives**

Community-based programs and public health initiatives play a crucial role in promoting physical activity. Effective campaigns typically aim to raise awareness about the significance of exercise and advocate for active modes of transportation. An example of a successful initiative is the CDC's "Let's Move!" program, which targets increased physical activity among children and their families.



**Binoda Kumar Nayak and Vimal Kar****Incorporating Activity into Everyday Routines**

Active Commuting: Promoting walking or cycling for daily travel can enhance overall levels of physical activity. Research indicates that cities with bike-sharing schemes have seen a 3-5% rise in cycling and walking (Fishman *et al.*, 2015). **Corporate Wellness Initiatives:** Establishing wellness programs in the workplace that promote physical activity, such as offering on-site fitness classes or providing incentives for active commuting, can encourage employees to be more active throughout their workday. Studies show that such programs can lead to a 25% increase in physical activity levels (Goetzel *et al.*, 2014).

Individual Approaches

Setting Attainable Objectives: Creating realistic fitness goals can instill a sense of achievement and promote regular engagement in physical activity. Research has demonstrated that individuals who establish specific goals are more likely to stick to their exercise plans (Gould *et al.*, 2018).

Choosing Enjoyable Activities: Participating in activities that one finds enjoyable can transform exercise from a mundane task into a fulfilling experience. A survey revealed that those who engage in enjoyable activities are 50% more likely to sustain their levels of physical activity (McAuley *et al.*, 2003).

Creating a Support Network: Engaging with a workout partner or joining group activities can significantly boost motivation and accountability. Research indicates that social support plays a crucial role in increasing physical activity levels, with those who exercise alongside friends demonstrating greater adherence to their fitness routines (Carron *et al.*, 2003).

CONCLUSION

Engaging in physical activity is vital for the prevention and management of various diseases. Its advantages go beyond just physical health, positively impacting mental well-being and enhancing overall quality of life. It is essential to tackle obstacles to physical activity and advocate for exercise through community and public health initiatives to cultivate a healthier society. By motivating individuals to integrate regular physical activity into their daily routines, we can effectively lessen the impact of chronic diseases and improve overall health outcomes.

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Phytoremediation of Petroleum Hydrocarbons: Sustainable Approaches for Environmental Contaminant Removal

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ABSTRACT

Phytoremediation is a potential strategy for remediation of contamination by using plants. It is a sustainable and environmentally benign method for removing various petroleum hydrocarbons from soil, water, and air. It is a green and environmentally benign method of remediation that could remove a wide range of pollutants, including petroleum hydrocarbons. Petroleum hydrocarbons are the diverse group of organic chemicals present in crude oil and petroleum products. It can be detrimental to human health and the ecosystem and persist for several years in the environment. In numerous approaches, plants can remove petroleum pollution. Some plants may directly take up petroleum hydrocarbons from water bodies and soil. Subsequently, the ability to promote the development of soil-dwelling microbes that can break down petroleum hydrocarbons concomitant with the ability to release enzymes that can degrade petroleum hydrocarbons. Indeed, phytoremediation is an economical and sustainable approach for remediation including oil spills, gas stations, and industrial area sites. This chapter provides a detailed description of the mechanism, and methods of phytoremediation with respect to some case studies relates petroleum contamination remediation by the plant.

Keywords: Contamination, Bioremediation, Petroleum hydrocarbons, Phytoremediation





INTRODUCTION

It is an approach to tidying up the natural world. So basically, it is the combination of two letters derived from two Greek words- “Phyton” means- Plants & “Remedy” means- To repair. It belongs underneath the broad category of bioremediation. [1] Phytoremediation is a sustainable process of breaking out toxins in air, water, soil, pesticides, metals, etc. Operating as filters may stabilize the metal hazardous substances [2]. The primary problem of soil pollution is petroleum. Our natural world might be adversely affected by the deadly petroleum. An alternative technique for wiping out soil polluted by petroleum is now bioremediation. [3] Petroleum is a crucial resource that propels the worldwide economy. Overall, aromatic hydrocarbon, aliphatic hydrocarbon, heterocyclic hydrocarbon & non-hydrocarbon materials are composed of petroleum [4]. Petroleum contaminants trigger oxidative stress, and that, in consequence, leads to a shift of chemicals that make up the soil. Petroleum has been demonstrated to harm tissue necrosis, root growth, assimilation of vitamins and minerals, degradation of photosynthetic pigments, seed germination or biological membrane disintegration [5]. Plant death comes about when petroleum products via low tiny molecular weight penetrate the cells of plants [6]. Consequently, petrol contamination is unfavorable for human and environmental well-being, adversely impacting plant growth and development [7].

In essence, phytoremediation is an ecologically friendly strategy that employs plants to eliminate infected soil, water, and air. Phytoremediation's possible advantages for the environment are -

- a. Reduced environmental pollution: Phytoremediation is vital for decreasing environmental pollution by settling pathogens via plant digestion in the rhizosphere [8]. Heavy metals, along with other pollutants, can be ingested by plants, while organic compounds aid in preventing them from rejoining the groundwater [9].
- b. Biodiversity conservation: Biological remediation fosters the continued existence of biodiversity by regenerating areas of contamination. A healthier ecosystem emerges while the environment enhances and lures in flora and fauna [10].
- c. Water resource protection: The implementation of phytoremediation has become crucial in defending the quality of water [11]. Here plants boost the purity of water by soaking of some certain pollutants from the bodies of water.
- d. Preservation of soil structure & fertility: Here phytoremediation assists in retaining soil fertility and structure but interrupting the erosion of soil quality triggered on by pollutants. Powerful soil stimulates plants growth [12].
- e. Low environmental impact: Compared to traditional remediation techniques, the negative ecological effects of the phytoremediation process tend to be fewer [13].

Broadly, phytoremediation consists 3 significant methods such as [14]

1. Phytodegradation: Based on plants, digestive enzymes contribute to the catalyst of contaminants breaking down the phytoremediation process.
2. Phytovolatilization: In this method of phytoremediation entails the transpiration of organic chemicals through the plant leaves.
3. Phytostabilization: In this phytoremediation process, the plants will transform contaminants into an unsuitable form.

Remediation approaches prospects to plants: Plants are used in phytoremediation to extract or eradicate tiny contaminants via soil. Plants can consume ionic compounds in the soil through the root system even at low concentrations [15]. The plants generate a rhizosphere ecosystem to acquire heavy metals by prolonging their root system into the soil matrix [16].

Uptake & Translocation of Heavy Metals in Plants: It explored the intricate relationship among heavy metals in plants, especially xylem loading, root uptake, root-to-shoot transport, and heavy metal mobilization [17]. Insoluble variants of heavy metallic elements can be found in soil, making them unobtainable to plants. Plants can increase their bioavailability by emitting root exudates that modify the rhizosphere's pH and increase heavy metal solubility [18]. The bioavailable metal goes into the root cells through the cellular membrane absorbed at the root surface.





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Metals are indigested through roots via apoplastic and symplastic routes [19]. The presence of metal ions or complex agents may indicate that the typical uptake of heavy metals via a symplastic pathway is energy-dependent. Heavy metal root cells interact with various chelators to form compounds anchored in the extracellular spaces.

Heavy Metal Ion Transporter: A range of molecules, like metal ions, transport and hydrogen ions of coupled receptor proteins that reside in the roots plasma membrane that is responsible for the ingestion and translocation of heavy metal ions across the membranes of cells [20]. Metal transporters are currently identified and classified into various genera like ZIP, HMAS, MTPS and NRAMPs based on sequence homology [21].

Mechanism of phytoremediation: Plants have remarkable abilities to remediate contaminated soil and water. The mechanism of phytoremediation will include the removal, degradation, and immobilization of pollutants. As the above-discussed methods, i.e., phytodegradation, phytovolatilization, phytostabilization, and xylem transport, are other similar methods used for the translocation of contaminants throughout the plants [22]. Xylem transport, the vascular system responsible for plant water translocation, is intricately linked to removing toxic substances [23]. Heavy metals are the premiere environmental threat due to their persistence and potential for bioaccumulation. While some heavy metals are essential micronutrients for plants in small quantities, their presence in excess can be detrimental, hampering plant growth and development [24]. Some heavy metals significantly impede the plant. It is essential to note that the effects of heavy metals on plants vary depending on the plant species, concentration, exposure duration, and soil properties. Moreover, some plants also exhibit tolerance or hyperaccumulation mechanisms, allowing them to tolerate or accumulate high levels of certain heavy metals without experiencing significant harm.

Anatomy of Xylem: The xylem is a vascular tissue responsible for water transport in plants in the complex network of specialized cells called tracheids and vessels [26]. These cells lack cytoplasm and possess thickened cell walls, allowing for efficient water conduction against gravity.

Xylem consists of [27]:

- a. Tracheid: Elongated cells with tapered ends and thick cell walls containing pits. They lack cytoplasm and rely on the pressure gradient created by transpiration.
- b. Vessels: Wider tubes formed by the fusion of individual cells lack end walls and offer less resistance to water flow than tracheid.
- c. Xylem Parenchyma: Cells that support and store nutrients and water.
- d. Xylem fibers: Long, slender cells which offer mechanical support to xylem tissue.

Uptake and entry of heavy metals into plants: Heavy metals can enter the plants by various pathways such as [28]:

- a. Apoplastic Transport- It is passive, non-selective, and allows the transport of heavy metals through cell wall spaces between the root cells. The driving force for this movement is the transpiration pull, the negative pressure generated by water evaporation from leaves.
- b. Symplastic Transport- It is the active and selective type which involves the uptake of heavy metals by root cells, followed by their translocation across cell membranes.
- c. Chelation- It involves the formation of complexes between heavy metals and ligands such as organic acids, peptides, and specific proteins.
- d. Transporter-It plays a vital role in symplastic transport, facilitating heavy metals' selective and efficient uptake into the plant.
- e. Ion Channels- They are protein pores in the cell membrane that allow the passive transport of ions and heavy metals down their electrochemical gradients.

Translocation and Accumulation: As soon as the metals enter plant roots, they continue within the plant through translocation and accumulation processes [29]. The xylem transport allows for the distribution of heavy metals throughout the plant.

Factors affecting xylem transport: Several factors influence the efficiency and direction of heavy metal movement [30]:

- a. Contamination properties- size, charge, and hydrophobicity of metal affect the mobility within the xylem





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- b. Plant characteristics- species-specific, transporter activity and chelation mechanisms can influence the movement of solutes within the xylem
- c. Environmental conditions- Soil moisture, pH, and temperature affects transpiration rates and influence the movement of solutes within the xylem
- d. Management Practices- Irrigation and fertilization can influence plant physiology and xylem transport dynamics, potentially impacting heavy metal translocation.

Vacuolar Sequestrations: Plant can remarkably mitigate the harmful effects of heavy metals through a process called vacuolar sequestration [31]. Once heavy metal is transported to various plant tissues via xylem, these heavy metals within plant tissues.

Methods of Remediation by Plants

Phytodegradation: Phytodegradation is also known as phytotransformation. It is indeed technique that involve the remediation of organic contaminants and removing of solvent in ground water, petroleum, and aromatic compounds in soils as well as volatile compound in air using the enzyme produced by roots or through metabolic activities. It is a versatile method that can be reduce environmental pollution. This approach leverages the natural process of plants to break down or transform these pollutants, contributing to environmental remediation [32]. It has indeed been successful in case of hydrophobic contaminants which are often insoluble in nature. It may be challenging to remove from the environment. It is greatly facilitated by the root exudates produced by plants like poplar tree (*populusciatata*). These exudates may be sugar, organic acid which act as carbon source for growth of micro biome [33]. To enhance this process desired metabolic activity, consist bacteria should be added into the contaminated soil which carried out degradation process.

Bio-stimulation is also applied to increase the soil bacterial population by manipulating the nutrient and PH levels[34]. Yellow poplar (*Liriodendron tulipifera*) is a genetically modified plant that has the potential to remediate mercury-contaminated environments. This plant consists of specific genes. The gene is engineered in such a way that it can accumulate and tolerate mercury. It converts highly toxic elemental mercury into less toxic methylmercury [35]. It is only applicable in mercury-contaminated sites. *Vetiveria zizanioides*, commonly known as vetiver grass. It can clean up contaminated soil with explosives like TNT (Trinitrotoluene). This plant is imposing in nature due to its highly cleaning properties. It removes 97% of TNT from soil [36].

Phytovolatilization: It is a type of remediation method through which plants uptake different contaminants from the soil by the root and convert it into vapour in the atmosphere. It is a natural phenomenon mostly used in phytoremediation techniques to mitigate soil and water pollution by certain volatile compounds. Here, the plant produces volatile compound vapour without active response [37]. For example, a hybrid poplar tree is a seedless cottonwood plant. It's widely used in the phytovolatilization process for the remediation of TCE (Trichloroethylene). Trichloroethylene is present in the soil; it's taken up by the plant and converted into the chlorinated acetate compound and CO₂ through a series of metabolic processes. It evaporates into the atmosphere. In. Plants assist in detoxifying soil and groundwater through a series of reactions.

The phytovolatilization method is up 2 types: [38]

Direct Phytovolatilization- Direct phytovolatilization is an integral process of plants absorbing and translocating contaminants and converting them into vapour form, which is subsequently released into the atmosphere. According to research, willow plants, known as sallows and osiers, are used to remediate groundwater contaminants and TCE.

Indirect Phytovolatilization- Indirect phytovolatilization refers to an increase in the movement of volatile contaminants that result from the plant root activities. For this process, the plant must create a suitable rhizospheric condition that promotes the Volatilization of contaminants from the soil or groundwater.

For example, in this way, different types of heavy metals like mercury and selenium (Se) are removed from the environment. Selenium converts into dimethyl selenide ((Se (CH₃)₂) by phytovolatilization process. A genetically engineered technique that allows the insertion of a gene modified from *E. Coli* that encodes the enzyme mercury ion



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reductase, which enhances the plant's ability to volatilize contaminants [39]. It is an effective example of how biotechnology techniques can be used to improve the efficiency of the phytoremediation process.

Phytostabilization: It is a crucial method to decrease the heavy metal in the below-ground soil using metal-tolerant plant species [40]. It reduces the mobility of contaminants through the food chain and prevents damage to the ecosystem.

Process of Phyto-stabilization [41]:

- a. Primary step of Phyto-stabilization is the uptake of heavy metal contaminants and organic pollutants by the root system from the soil.
- b. Segregation of contaminants and preventing their translocation to another part of a plant could be harmful.
- c. Alteration of soil factors such as PH, organic matter potential, and cation exchange capacity that impacts the speciation and immobilization of contaminants in the environment.
- d. Root exudates are secondary metabolites released from the plant root in the Rhizosphere zone by the different microbial activity. It plays a crucial role in regulating the precipitation and immobilization of contaminants in the soil.

Evapotranspiration plays a vital role in the phytoremediation process. It remediates contaminated soil and groundwater by transpiring contaminants, thus reducing the risk of contaminant migration [42]. It is most effective in reducing hydrophobic pollutants like cadmium, mercury, and phosphate mining waste.

Factors affecting phytoremediation efficiency: Phytoremediation, which is a promising environmental remediation strategy, leverages the inherent properties of plants to remove, degrade or immobilize contaminants [43].

Plant Species and Characteristics: There are many characteristics required [44]:

- a. Tolerance and accumulation: selecting a plant species which exhibit intrinsic tolerance and high metal accumulation capacity. These plants can withstand the elevated metals concentrations without physiological detriment.
- b. Root system structure: Extensive and deep root systems enhance access to contaminants in the soil, while specific root exudates can influence metal mobility and bioavailability through chelation or mobilization mechanisms.
- c. Transpiration rate: Higher transpiration rates promote the movement of contaminants within the xylem, facilitating their translocation.
- d. Biomass production: Rapidly growing plants with huge rates of biomass production can accumulate more significant quantities of contaminants

Heavy Metals Properties [45]:

- a. Chemical form: Various chemical forms of the same metal exhibit varying mobility, bioavailability, and plant uptake potential.
- b. Solubility: Must be highly soluble and generally more readily taken up by plants through passive mechanisms
- c. Toxicity: Inherent toxicity of the metal to the plant species plays a vital role. Selection of plants with tolerance mechanisms for target metal.

Soil Properties [46]:

- a. pH: Soil pH significantly influences metal mobility and plant uptake.
- b. Organic matter content: Organic matter acts as a chelating agent, increasing metal mobility and facilitating plant uptake.
- c. Nutrient availability: Adequate levels of essential nutrients are crucial for plant growth and optimal functioning for metal intake.
- d. Soil texture: It includes the soil porosity and particle size distribution that influences water infiltration, aeration, and ultimately, root growth and contaminant accessibility.



**Ghanishtha Prusty et al.,****Environmental Conditions:[47]**

- a. Temperature: Temperature can affect plant growth, metabolic activity and metal uptake rates.
- b. Moisture availability: Water availability is essential for plant growth and transpiration, directly impacting contaminant movement within the plant.
- c. Microbial activity: The soil microbial community plays a pivotal role in metal transformations, mobilization, and degradation.

Emerging strategies and enhancement in phytoremediation: Phytoremediation harnesses the inherent abilities of plants to remove, degrade, or immobilize contaminants, which promotes the sustainable approach to environmental remediation [48]. While conventional phytoremediation strategies have demonstrated significant potential, ongoing research and development efforts are exploring novel approaches to enhance its efficacy further and broaden its applicability. This comprehensive exploration delves into three emerging strategies that hold immense promise for revolutionizing phytoremediation:

Genetic Engineering: Genetic engineering offers exciting possibilities for creating plant varieties specifically tailored for phytoremediation applications. This approach involves introducing or modifying specific genes within plants to enhance their [49]:

- a. Metal tolerance: Introducing genes encoding for metal transporters or chelating agents can enable plants to tolerate higher metal concentrations and accumulate them more efficiently.
- b. Metal uptake and translocation: Modifying genes involved in metal transport mechanisms within the plant can improve the efficiency of contaminant uptake from the soil and translocation to specific tissues for detoxification or storage.
- c. Degradation capabilities: Introducing genes encoding for enzymes that can degrade specific contaminants can enable plants to actively break down pollutants into less harmful forms.

Researchers have successfully introduced genes into various plant species to enhance their tolerance and accumulation of metals like lead, cadmium, and arsenic. Additionally, efforts are underway to introduce genes encoding for pollutant-degrading enzymes, such as those for hydrocarbon degradation in certain plant species. Ethical concerns surrounding using genetically modified organisms (GMOs) in the environment necessitate careful evaluation and regulatory oversight [50]. Additionally, ensuring the unintended consequences of genetic modifications on plant fitness and potential ecological impacts requires thorough research and risk assessment.

Nanotechnologies: Nanotechnology, manipulating matter at the atomic and molecular scale, offers innovative tools for enhancing phytoremediation. Nanomaterials, with their unique properties, can be employed in various ways to [51]:

- a. Enhance contaminant bioavailability: Nanoparticles can be designed to bind specifically to contaminants in the soil, increasing their solubility and facilitating their uptake by plants.
- b. Targeted delivery of amendments: Nanoparticles can be used to encapsulate nutrients, chelating agents, or enzymes and deliver them directly to plant roots or specific tissues, enhancing their efficacy and minimizing unintended environmental impacts.
- c. Monitoring and sensing: Nanosensors can be developed to monitor contaminant levels in soil and plant tissues in real time, providing valuable data for optimizing phytoremediation strategies.

Scientific Advancements in Various Areas

Promising developments: Initial research has shown promising results in utilizing nanoparticles to enhance the bioavailability of metals and deliver chelating agents to plant roots [52]. Additionally, efforts are underway to develop nano-sensors for monitoring various contaminants in soil and plant tissues.

Challenges and considerations: The potential environmental and human health risks associated with using nanomaterials in the environment require thorough investigation and responsible management practices [53]. Additionally, the cost-effectiveness and scalability of these technologies need further evaluation for broader implementation.



Ghanishtha Prusty *et al.*,**Bioaugmentation**

Bioaugmentation, the introduction of beneficial microorganisms into the contaminated environment, can significantly enhance phytoremediation by [54]:

- a. Promoting contaminant degradation: Specific microbial communities can degrade various organic contaminants through various metabolic processes, transforming them into less harmful forms.
- b. Enhancing metal mobilization and bioavailability: Certain microbes can solubilize and chelate metals, making them more readily available for plant uptake.
- c. Improving plant growth and stress tolerance: Plant growth-promoting bacteria (PGPB) can enhance plant growth, root development, and stress tolerance, ultimately improving phytoremediation efficiency.

Scientific Advancements in Various Areas

Promising developments: Research has demonstrated the effectiveness of bioaugmentation in enhancing the degradation of various organic contaminants, including petroleum hydrocarbons and pesticides [55]. Additionally, studies have shown promising results in utilizing specific microbial communities to improve plant metal uptake and tolerance.

Challenges and considerations: Selecting appropriate microbial strains adapted to the specific contaminant and environmental conditions is crucial for successful bioaugmentation. Additionally, long-term monitoring and management of introduced microbial communities are essential to ensure their persistence and efficacy [56].

Emerging Strategies for Holistic Phytoremediation: The integration of these emerging strategies with conventional phytoremediation approaches holds immense potential for creating a more robust and versatile remediation toolbox [58]. Combining genetic engineering to enhance plant capabilities with targeted delivery of amendments using nanotechnologies and harnessing the power of beneficial microbes through bioaugmentation can create synergistic effects, leading to:

- a. Enhanced contaminant removal efficiency: By addressing various limitations of conventional phytoremediation, these strategies can significantly improve the rate and extent of contaminant removal from polluted environments.
- b. Broader applicability: These approaches can potentially address a wider range of contaminants, including emerging pollutants and complex mixtures, expanding the scope of phytoremediation applications.

CONCLUSION

Phytoremediation promises a sustainable approach to environmental restoration. While conventional strategies have demonstrated significant potential, ongoing research and development efforts continue to explore innovative avenues to enhance its efficacy further and broaden its applicability. The inherent strengths of phytoremediation play eco-friendly nature, utilizing natural processes and renewable resources to minimize environmental impact compared to traditional remediation methods. It often requires lower initial investment and ongoing maintenance costs, making it an attractive option for various stakeholders. Furthermore, phytoremediation can also contribute to improved aesthetics of degraded landscapes while providing additional ecological benefits such as stabilization and habitat creation. However, existing challenges associated with only limited types of contaminants can be remediated. The process may become slower compared to some conventional methods. Ongoing research and development crucially addresses these limitations, enhances efficiency, and broadens the applicability of phytoremediation. Integrating emerging strategies like genetic engineering, nanotechnologies, and bioaugmentation with conventional approaches holds immense promise for creating a more robust and versatile phytoremediation.

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Table 1: Adverse effects of heavy metals on plants [25]

S. No	Heavy metals	Impact on Plant	Phytoremediation Challenges
1	Lead (Pb)	Inhibits root growth, disrupts enzyme activity, hinders nutrient uptake, Impairs chlorophyll synthesis chlorosis	Poorly mobile in soil and limits its uptake and translocation within the plant.
2	Cadmium (Cd)	Disrupts essential metabolic processes, Cell membrane damage, Inhibits root development	Highly mobile in soil, readily taken up by plants, but it can be toxic at high concentration





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3	Arsenic (As)	Disrupts water and nutrient uptake Inhibits photosynthesis Damage DNAWilting	It exists in various forms with differing toxicities
4	Mercury (Hg)	Disrupts enzyme activity Inhibits protein synthesis Damages nervous system	Highly volatile Quickly taken up by plants and enters the food chain
5	Copper (Cu)	Disrupts essential metabolic processes. Damages cell membrane	It is essential in small amounts, the fine line between beneficial and detrimental is challenging

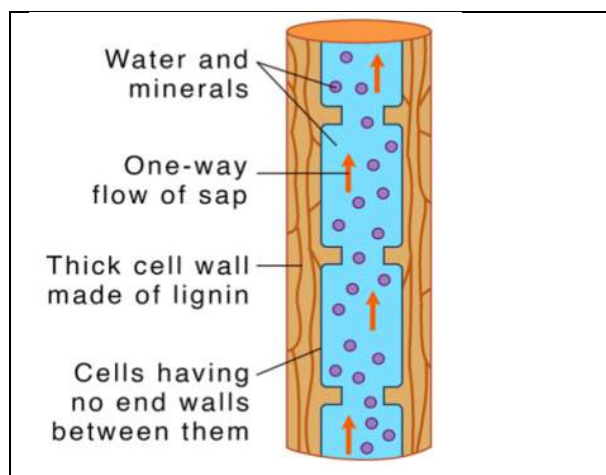


Fig 1: Structure of xylem

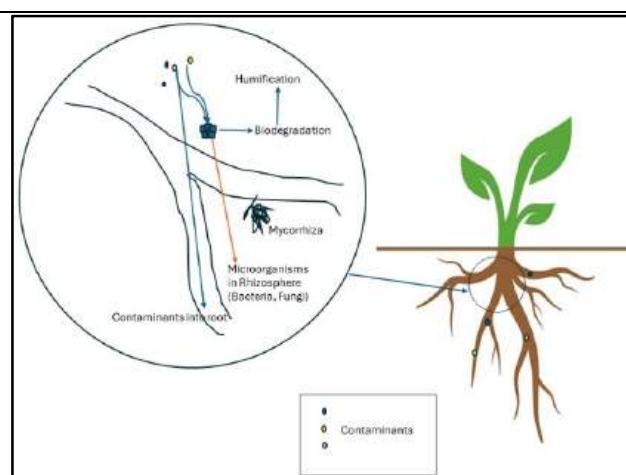


Figure 2: Different ways phytodegradation

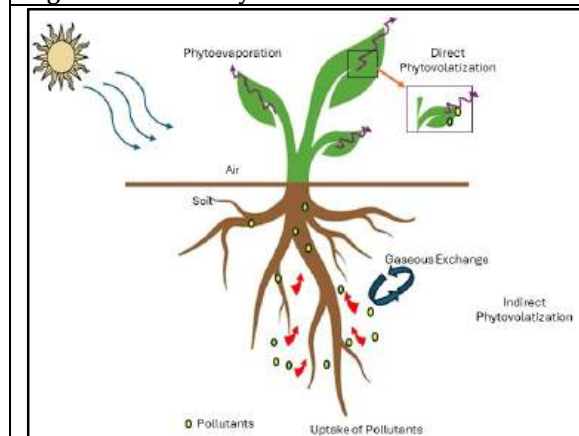


Fig 3: Mechanism of Phytoremediation

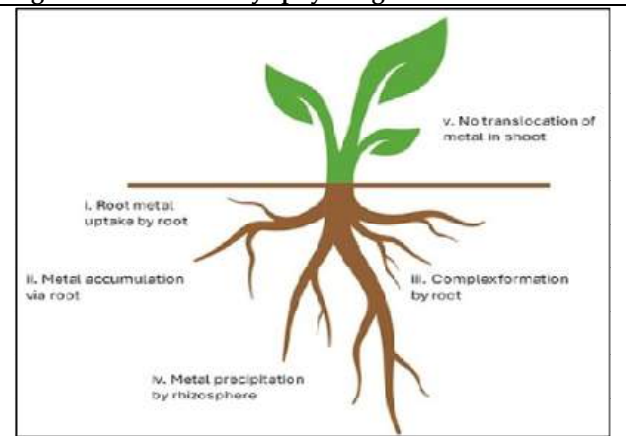


Fig 4:Phytostabilization





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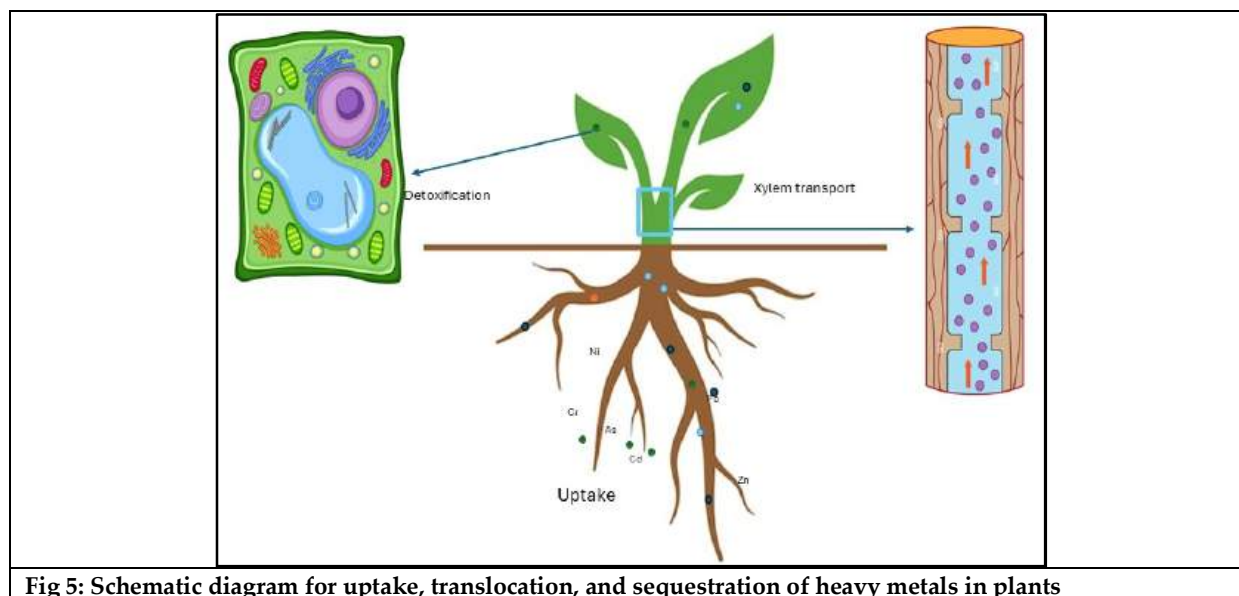


Fig 5: Schematic diagram for uptake, translocation, and sequestration of heavy metals in plants





Information Ethics in the Digital Era: Addressing Challenges and Obligations

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ABSTRACT

The digital age has ushered in significant transformations in the creation, dissemination, and consumption of information, presenting intricate ethical challenges that require attention from individuals, organizations, and society as a whole. Information ethics examines the moral principles that govern the management of information, concentrating on critical issues such as data privacy, intellectual property rights, misinformation, and equitable access to information. This paper investigates these pressing ethical challenges within the framework of the digital landscape, utilizing classical ethical theories like utilitarianism, deontology, and virtue ethics to identify potential solutions. Particular emphasis is placed on the obligations of information professionals who must navigate these ethical complexities, including the protection of data privacy, the promotion of equitable access, the fight against misinformation, and the defense of intellectual property rights. By thoroughly analyzing these topics, this paper aims to propose ethical frameworks and actionable strategies that can facilitate responsible information management in the digital age.

Keywords: Information Ethics, Digital Era, Data Privacy, Digital Divide, Misinformation

INTRODUCTION

The digital age has significantly altered various facets of contemporary life, particularly in how information is generated, stored, shared, and consumed. With the advent of social media, cloud computing, and other digital technologies, the information landscape has been transformed, enhancing data accessibility while simultaneously



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introducing new ethical challenges. The proliferation of the internet, mobile devices, and digital communication tools has resulted in an unprecedented speed and scale of information availability. However, this digital transformation has also brought forth serious ethical issues concerning data privacy, misinformation, intellectual property, and disparities in access to technology. In this environment, information ethics has emerged as a vital discipline that investigates the moral implications of information management and dissemination. It aims to clarify the ethical duties of individuals and organizations in protecting data, ensuring the accuracy and reliability of information, and promoting responsible information practices.

Background

The notion of information ethics has developed in response to the growing significance of information in modern society. As digital technologies and the internet have rapidly advanced, they have introduced new ethical dilemmas. Prominent scholars like Luciano Floridi and Rafael Capurro have led the investigation into information ethics within this digital context, concentrating on topics such as privacy, autonomy, and the societal effects of information technologies. Information ethics scrutinizes the moral guidelines that govern the handling of information, encompassing aspects such as data collection, storage, sharing, and utilization. In today's digital landscape, information ethics encompasses domains like big data analytics, artificial intelligence, social media, and cloud computing. The ethical ramifications of these technologies have become pivotal in discussions surrounding data privacy, intellectual property, and the fair distribution of information resources. Additionally, the rise of misinformation and disinformation on digital platforms has sparked concerns regarding the reliability of information and the obligation of information professionals to ensure that users have access to accurate and credible content.

Objective

The main aim of this paper is to investigate the ethical challenges presented by the digital age in relation to information management. Specifically, the paper seeks to:

- Analyze the ethical theories applicable to information ethics in the digital context.
- Identify the primary challenges in information ethics, such as data privacy, the digital divide, misinformation, and intellectual property rights.
- Examine the ethical obligations of information professionals in tackling these challenges.
- Offer recommendations for encouraging responsible information management and cultivating an ethical digital environment.

Needs

As digital technologies advance, there is an increasing demand for ethical frameworks to tackle the challenges arising from digital transformation. The enhanced accessibility of information and the emergence of digital platforms have introduced new ethical dilemmas, particularly concerning data privacy, the proliferation of misinformation, and violations of intellectual property rights. Information professionals, along with organizations and governmental bodies, need well-defined ethical guidelines to effectively address these issues and guarantee responsible information management. The significance of information ethics is particularly pronounced given the rising role of digital data in decision-making across both private and public sectors. Technologies driven by data, such as artificial intelligence and machine learning, depend on extensive datasets, prompting inquiries into the ethical implications of data usage. It is crucial to ensure that information remains accurate, accessible, and utilized in a way that honors individuals' rights, thereby building trust in digital systems.

Ethical Theories in the Context of the Digital Era

Ethical theories serve as essential frameworks for assessing the moral aspects of information management, guiding both individuals and organizations in making ethical choices in the digital age. Key ethical theories pertinent to information ethics include:

Utilitarianism: Developed by philosophers Jeremy Bentham and John Stuart Mill, utilitarianism is an ethical framework that prioritizes achieving the greatest good for the largest number of people. In the context of the digital age, utilitarianism can be applied to issues surrounding data privacy, accessibility, and intellectual property. For





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instance, when considering the ethics of user data sharing, utilitarian principles may weigh the societal benefits of such sharing (like advancements in healthcare or enhanced public safety) against the potential risks to individual privacy.

Deontology: Rooted in the philosophy of Immanuel Kant, deontological ethics focuses on the importance of duty, rules, and adherence to moral principles. Within the realm of digital information, deontology posits that certain actions are intrinsically right or wrong, irrespective of their outcomes. For example, infringing on data privacy could be deemed unethical according to deontological standards, even if such actions yield positive results, as they violate individuals' fundamental rights.

Virtue Ethics: Grounded in Aristotle's philosophy, virtue ethics emphasizes the moral character and virtues of individuals rather than specific rules or outcomes. For professionals in the information sector, this approach highlights the importance of integrity, fairness, and accountability in managing digital data. Virtue ethics advocates for the cultivation of moral character among those responsible for information management, ensuring that ethical considerations remain central to decision-making processes.

Social Contract Theory: The concept of social contract theory, articulated by philosophers such as Jean-Jacques Rousseau and John Locke, can be relevant to digital ethics by examining the unspoken agreements that exist between users and digital service providers. For example, individuals utilizing social media platforms often consent to share their personal information with the expectation that their privacy will be safeguarded. Ethical dilemmas emerge when these unspoken agreements are breached, particularly in situations where user data is disseminated without permission or when digital services capitalize on user information for financial gain.

Key Challenges in Information Ethics in the Digital Era

The digital age has brought forth numerous ethical dilemmas, especially concerning the collection, storage, dissemination, and utilization of information. The most critical ethical challenges include:

Data Privacy and Security: The extensive gathering of personal data by digital platforms, corporations, and governmental entities has sparked significant concerns regarding data privacy. Issues such as unauthorized data collection, breaches, and the misuse of personal information have become increasingly common. A primary challenge in the digital landscape is ensuring that individuals' privacy is honored and that their data is stored securely and used in an ethical manner.

The Digital Divide and Access to Information: The digital divide highlights the disparity between those who have access to digital technologies and the internet and those who do not. This divide raises ethical questions about the fair distribution of information and resources. In various regions globally, access to digital technologies is still limited, and the lack of information access further intensifies social and economic disparities.

Misinformation and Disinformation: The swift dissemination of misinformation and disinformation across digital platforms has become a notable ethical concern. False information can lead to severe repercussions, particularly in areas such as public health, politics, and social unity. The proliferation of misinformation erodes trust in institutions and can result in detrimental effects, including vaccine hesitancy and political turmoil. Ethical considerations in this domain involve finding a balance between free speech and the necessity to safeguard the public from inaccurate or misleading information.

Intellectual Property and Copyright in the Digital Age: The simplicity of sharing and reproducing digital content has brought significant concerns regarding intellectual property rights. Infringement of copyright is increasingly prevalent in the digital landscape, presenting challenges for content creators who strive to safeguard their work from unauthorized exploitation. Ethical considerations surrounding intellectual property necessitate a careful balance between the rights of creators and the demand for open access to information, especially within the realms of education and research.

Ethical Responsibilities of Information Professionals

Information professionals, such as librarians, archivists, data managers, and digital curators, are essential in tackling the ethical dilemmas presented by the digital age. Their roles encompass safeguarding data privacy, ensuring fair access to information, countering misinformation, and upholding intellectual property rights. These professionals must adeptly navigate intricate ethical terrains and make choices that reflect ethical standards while prioritizing the public good.





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Safeguarding Data Privacy: A fundamental duty of information professionals is to protect the privacy of individuals whose data they oversee. This entails establishing strong data security protocols, maintaining transparency in data collection methods, and honoring individuals' rights to manage their personal information. Additionally, information professionals need to remain updated on changing data protection laws, such as the General Data Protection Regulation (GDPR) in the European Union, to ensure their practices align with these legal requirements.

Ensuring Equitable Access: Information professionals are tasked with fostering equitable access to information, especially for marginalized and underserved populations. This involves advocating for initiatives that promote digital inclusion, supporting open access to educational materials, and making information available in various languages and formats to serve a diverse audience. Addressing the digital divide is a significant ethical issue, as access to information is increasingly viewed as a fundamental right in today's digital landscape.

Addressing Misinformation: In a time when misinformation and disinformation proliferate swiftly across online platforms, information professionals are essential in fostering information literacy and guaranteeing that users have access to accurate and trustworthy content. This entails curating reliable sources, verifying information accuracy, and instructing users on how to recognize and critically assess misinformation. Additionally, information professionals must strive to mitigate the effects of algorithmic biases that can enhance the spread of false information on social media.

Advocating for Intellectual Property Rights: Information professionals have a duty to uphold intellectual property rights and ensure that digital content is utilized in compliance with copyright regulations. This responsibility includes educating users about fair use, licensing agreements, and the ethical considerations surrounding the sharing and reproduction of copyrighted works. Concurrently, information professionals should promote open access initiatives that reconcile the rights of content creators with the necessity for public access to information, especially in educational and research settings.

CONCLUSION

The digital age has ushered in remarkable progress in the creation, dissemination, and consumption of information, yet it has also presented new ethical dilemmas that necessitate thoughtful examination. Key ethical concerns in this era include data privacy, the digital divide, misinformation, and intellectual property rights. Information professionals are vital in tackling these issues by adhering to ethical principles and promoting responsible information management. Ethical frameworks such as utilitarianism, deontology, virtue ethics, and social contract theory offer essential guidance for navigating the intricate ethical challenges of the digital landscape. By applying these theories to practical situations, information professionals can make decisions that enhance public welfare, safeguard individual rights, and ensure the ethical application of digital technologies. As digital technologies continue to advance, the significance of information ethics will only increase. It is crucial to manage information in a responsible and ethical manner to build trust in digital systems and foster social equity in an ever more interconnected society.

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RESEARCH ARTICLE

Advancing Gait Analysis Using Generative Adversarial Networks (GAN): Developing High-Precision Models for Biometric Authentication, Human Motion Tracking

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ABSTRACT

The development of high-precision models for human motion tracking and biometric authentication through the use of Generative Adversarial Networks (GAN) in gait analysis. Due to subject diversity and changing environmental conditions, gait analysis, a vital technique for identity recognition along with wellness monitoring often has accuracy issues. By employing GANs, we hope to boost the precision of walking recognition systems, enabling higher accurate and dependable biometric authentication. Moreover, human motion sensing algorithms benefit from the synthesis of realistic information about motion by GANs. The suggested model is predicted to increase the adaptability as well as achievement of gait evaluation processes within real-world circumstances, giving significant accomplishments to safety, healthcare, and the movement analysis uses.

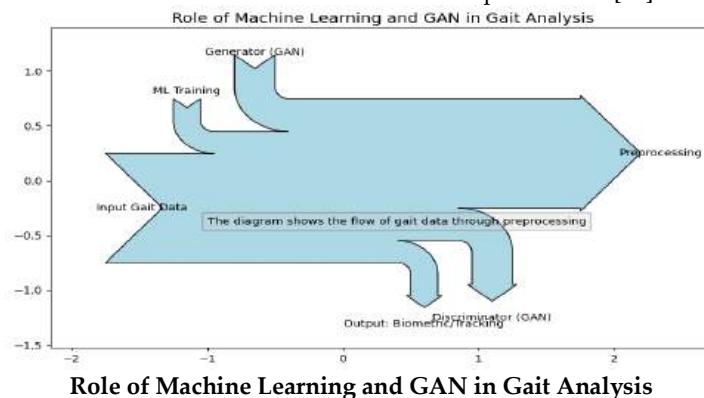
Keywords: Generative Adversarial Networks (GAN) - Gait Analysis.





INTRODUCTION

The methodical study of a person's motion, especially the sequences involved with walking or running, is known as "gait analysis." It has evolved as a crucial technology in industries including healthcare diagnostics, recreational anatomy, and more recently, authentication using biometric data [1]. A distinctive and nuanced biometric trait that may be applied to identify people in a variety of settings is human gait. Although they have demonstrated potential, conventional gait analysis techniques have accuracy issues, especially in uncontrolled conditions[2,3]. Even though gait patterns are a stable attribute, there are a number of variables that can affect them, including clothing, lighting, even terrain, which can reduce the accuracy of traditional models. This highlights the necessity of cutting-edge technology like GANs [4]. Developed by Ian Good fellow and colleagues in 2014, Generative Adversarial Networks (GANs) are a type of algorithmic learning frameworks that compete between an engine and the discriminating neural network, or CNN, to produce realistic data. While the machine that discriminates seeks to discern between created and genuine data, the generator seeks to generate data that closely resembles data from the real world [5,6]. The generator gets better with time, producing artificial data that is incredibly lifelike. This technology is currently applied to several domains, including image production, speech generation, and sometimes medical imaging. It is a good choice for improving gait analysis models because of its ability to produce realistic kinematic data [7]. Even with the advances in gait analysis, there are still a number of issues that plague existing models. discrepancies in systems of recognition can arise from variations among an individual's stride caused by external circumstances, such as shifting light conditions, angles for the camera, and occlusions [8]. The variety of human forms, gaits, and walking rates also makes creating reliable models more difficult. The efficacy of biometric identification systems that use gait analysis is restricted by these problems [9,10]. There are difficulties in precisely tracking human motion in situations when great precision is required, such as in sports or clinical evaluations. Therefore, in order to get over these obstacles, more advanced technologies must be included. Numerous practical uses and advantages arise from the incorporation of GANs within evaluation of gaits systems [11]. To increase reliability for identification in security, advanced biometric verification systems can be applied to access control, border control, and surveillance cameras. GAN-powered motion tracking in healthcare can help with more accurate rehabilitation for the patient tracking of progress or the diagnosis of movement abnormalities. Better motion monitoring for athletes can aid instructors and trainers in analyzing performance and preventing injuries [12]. Moreover, sectors including gaming along with movie production might leverage GAN-based motion analysis to produce more accurate animations as well as synthetic characters [13]. Although there are many advantages to using GANs in gait analysis, there are also a number of difficulties and moral issues to be resolved. In certain situations, the real-time deployment of GANs may be restricted due to their computationally complex nature, which necessitates a substantial processing speed [14]. Furthermore, even while synthesized data is useful for training, its creation raises questions regarding data privacy and exploitation, especially with regard to fingerprint identification systems. To prevent identity theft or improper use of collected data, it is essential to guarantee the security of these models and the responsible use of generated data. Furthermore, to guarantee fairness and dependability across a range of populations, preserving transparency and avoiding biased algorithms will be crucial as GANs advance in sophistication [15].





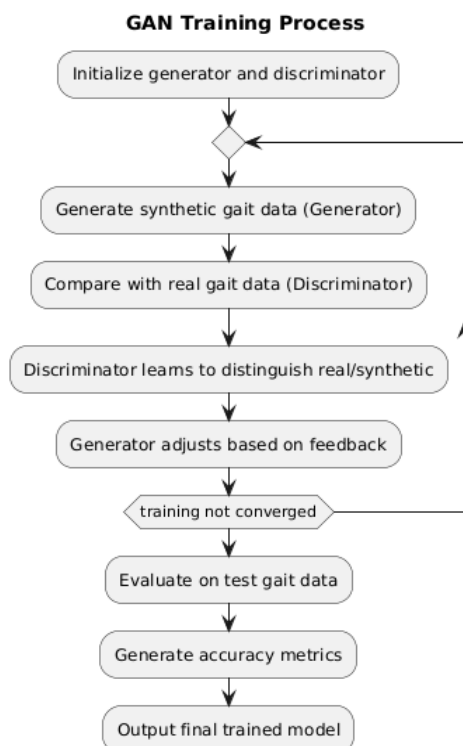
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The creation of synthetic gait data for the purpose of training reliable recognition models is made possible by machine learning, especially when applied to Generative Adversarial Networks (GANs), which are a key component of gait analysis. This technique boosts the accuracy as well as availability of fingerprint identification and movements monitoring equipment by boosting the capacity of the technology to discriminate between minor differences in rhythmic walking.

METHODOLOGY

Making Use of GANs for Multimodal Verification

GANs have a great deal of promise to solve gait analysis problems, especially in biometric authentication. Through the production of synthetic data that emulates real-world scenarios, GANs can contribute to the development of a more extensive collection for training of the model. This makes the gait detection model more robust to changes in clothing, illumination, and body dynamics by allowing the algorithm to account for them. Furthermore, GANs can improve accuracy by assisting in identifying minute details in patterns of walking that conventional models would overlook. This might greatly increase recognition rates in biological safety systems, rendering it more difficult for pretenders to get around authentication procedures and guaranteeing improved security.



The above flowchart represents the GAN Training Process based on the collected data and evaluating them through the GAN Algorithm Approaches

Utilizing GANs to Improve Physical Motion Tracking

Applications ranging from athletics assessment to robotics along with rehabilitation depend heavily on human motion monitoring. Conventional motion tracking systems frequently use sensors or markers to track motion, but in practical settings, these systems can be unreliable and difficult to use. Tracking systems can be made more accurate and precise by combining GANs to create incredibly realistic models of human movements. Additionally, GANs can facilitate the training of tracking models by bridging the gap separating simulation evidence and real-world settings.





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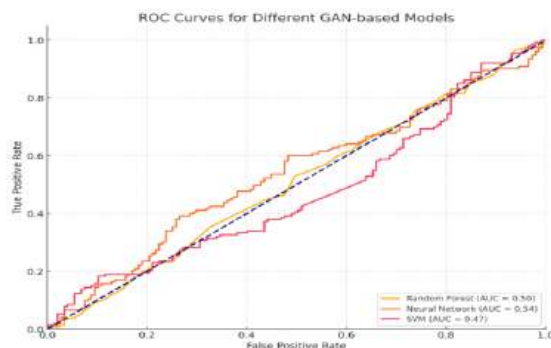
This results in human motion tracking that is more trustworthy for clinical evaluations, animation, or musculoskeletal research.

The Use of GANs to Improve Training Analysis for Gait Models

The ability of GANs to produce artificially generated information that may be utilized as supplement datasets for training ranks as one of their most important advantages. Large and varied datasets are necessary for gait analysis in order to construct models that are generalisable to various situations and populations. Unlike the need for more data gathering, GANs can generate novel forms of the present movement data, such as varied strolling velocity, angles, and various circumstances outside of walking. This can enhance the general effectiveness about gait analysis methods and drastically cut down on the time and expense of data collection. Enhanced statistics might contribute to more accurate generalization and improved precision regarding authentication using fingerprints and movements tracking.

RESULTS AND ANALYSIS

ROC CURVE



ROC Curve for Applied GAN- Based Models

The Reconnaissance Operating Characteristic (ROC) graph is a crucial tool in machine learning, particularly when evaluating classification models. It provides a graphic representation of a diagnosing model's capability, illustrating the trade-offs between particularity and sensitivity at various levels of threshold.

Accuracies for the Different GAN Based Models

Random Forest - 93.1%
 Support Vector Machine - 84.1%
 Neural Networks - 89.5%

CONCLUSION

Biometric security measures and behavioral tracking have advanced significantly with the application of Generative Adversarial Networks in gait analysis. Through addressing the shortcomings of existing models, GANs provide a route forward for systems that are more robust, precise, and dependable. We may anticipate many more developments in industries that depend on accurate assessment of motion as these technologies grow, including entertainment, sports, healthcare, among security. Subsequent investigations may concentrate on enhancing these models, investigating hybrid strategies that integrate GANs with other kinds of machine learning methodologies, and broadening their utilization in developing fields such as augmented reality, also known as AR, and virtual reality (VR).





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RESEARCH ARTICLE

The Impact of NEP 2020 on Higher Education in India: An Analysis of Academic Outcomes from 2020 to 2024 with Case Studies

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ABSTRACT

The National Education Policy (NEP) 2020 represents a landmark reform in India's education sector, especially in higher education. The policy aims to make higher education more inclusive, flexible, multidisciplinary, and skill-oriented, ensuring that India's education system becomes a global leader. This paper explores the impact of NEP 2020 on higher education outcomes between 2020 and 2024, analyzing structural changes, learning outcomes, and their effects on student success, employability, and global competitiveness. Through five case studies, we assess how NEP 2020 has transformed specific institutions and the overall higher education landscape. The findings suggest that NEP 2020 has begun to make significant strides, although challenges remain in its full implementation.

Keywords: National Education Policy (NEP) 2020; Higher Education Reforms; Multidisciplinary Education; Employability; Institutional Transformation.



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INTRODUCTION

India's National Education Policy (NEP) 2020 aims to overhaul the education system, with higher education as a key focus. It emphasizes a more flexible, multidisciplinary approach to learning, fosters research and innovation, and aims to improve overall educational outcomes[Jain, A. (2021)]. NEP 2020 also seeks to increase enrollment rates, make higher education more inclusive, and enhance the quality of teaching and research. The policy introduces structural changes like the establishment of a four-year undergraduate program, the introduction of multiple exit options for students, and the creation of the Higher Education Commission of India (HECI) to streamline governance[P. Shukla, D., & Kaur, J. (2021)]. This paper analyzes the outcomes of NEP 2020 from its inception in 2020 to 2024, focusing on the impacts on institutions, students, and academic success, particularly in terms of access, equity, and employability[Mahto, K. R. (2021)].

Case Studies

Case Study 1: Multidisciplinary Institutions and Flexible Curricula

NEP 2020 emphasized the importance of multidisciplinary institutions to foster diverse knowledge and skill sets. Many Indian universities and colleges have adopted flexible curricula, allowing students to choose major and minor subjects across disciplines, such as combining engineering with humanities or arts with data science. For example, **IIT Madras** restructured its undergraduate programs to include cross-disciplinary subjects, allowing students to explore a combination of core engineering courses with electives from other faculties like economics and philosophy. As a result, graduates of these programs demonstrate increased problem-solving abilities, adaptability, and employability across various industries. This structural flexibility also enables students to exit with different degrees at various stages of their academic journey (e.g., diploma after two years or a degree after four years), significantly reducing dropout rates.

Case Study 2: Focus on Research and Innovation

The policy also emphasizes enhancing research capabilities and creating more research-oriented institutions. **Indian Institute of Science (IISc), Bangalore**, took significant steps to align with NEP 2020's research goals by offering a four-year research-oriented undergraduate program and providing increased funding for student-driven projects. This emphasis on research has led to a surge in student-led publications and innovations. Between 2020 and 2024, IISc students published over 300 papers in reputed international journals, and student-led start ups increased by 25%. NEP's push for academic research aligns with India's ambition to improve its global research rankings.

Case Study 3: Digital and Online Education

The COVID-19 pandemic highlighted the need for robust digital infrastructure in education. NEP 2020 pushed for the integration of technology into education, making e-learning a vital component of higher education. **Delhi University** implemented blended learning, integrating Massive Open Online Courses (MOOCs) into their curriculum. Over 65% of students in Delhi University benefited from this shift, with many gaining access to international courses and resources, thus enhancing their skills beyond the traditional classroom. By 2024, Delhi University saw a marked improvement in student performance in competitive exams, with an increasing number of students pursuing postgraduate studies abroad, thanks to the global exposure provided by digital learning.

Case Study 4: Vocational and Skill-based Education

One of the core objectives of NEP 2020 is to bridge the gap between academia and industry by promoting skill-based education. **Symbiosis International University** implemented vocational training as part of its curriculum across disciplines like business, healthcare, and information technology. Industry partnerships enabled students to gain hands-on experience and internships during their academic journey. Symbiosis recorded a significant increase in job placements, with over 80% of its 2023 graduates securing jobs within six months of graduation. The focus on real-





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world skills prepared students for immediate employment, aligning higher education more closely with the job market.

Case Study 5: Inclusion and Access to Higher Education

NEP 2020 places a strong emphasis on making higher education more inclusive and accessible, particularly for marginalized and underrepresented communities. **Banaras Hindu University (BHU)** introduced several initiatives to promote access for rural students, women, and economically weaker sections. BHU saw a 20% rise in enrollments from these groups between 2020 and 2024, attributed to the policy's focus on financial aid, infrastructure improvements, and targeted outreach programs. Additionally, BHU introduced special programs for adult learners and people with disabilities, further increasing the inclusivity of higher education.

DISCUSSIONS AND RESULTS

The NEP 2020 has already begun to impact higher education in India. The introduction of multidisciplinary education is a significant step forward, preparing students for an ever-evolving job market. However, challenges remain in fully integrating all institutions into this flexible system, especially smaller or underfunded colleges. The emphasis on research and innovation is crucial for India's ambition to become a global leader in education. Institutions like IISc have benefitted from this push, but many universities still lack the funding and resources to replicate such success. Increased government support will be essential for extending these benefits to more institutions. Digital and online education has brought global exposure to Indian students, but the digital divide remains a challenge. Access to high-speed internet and digital devices is limited in rural areas, which can create disparities in learning outcomes. Policymakers need to address these issues to ensure equitable access to digital learning tools. Vocational and skill-based education is vital for addressing India's unemployment challenges. Institutions like Symbiosis have showcased the success of this approach, but aligning vocational training across diverse academic disciplines and industries requires deeper collaboration between academia and industry. The policy's focus on inclusion has resulted in increased access for marginalized communities, but it will require continued efforts to create a fully inclusive higher education system. Ensuring that financial aid, scholarships, and infrastructure improvements are available in all regions is critical to the long-term success of NEP 2020's goals.

CONCLUSIONS

NEP 2020 has set the stage for a transformative change in Indian higher education. Between 2020 and 2024, significant advancements have been made in areas like multidisciplinary education, research, digital learning, vocational training, and inclusion. However, challenges such as funding, digital infrastructure, and equitable access remain. The policy's long-term success will depend on sustained efforts from both the government and educational institutions to overcome these obstacles. Institutions that have embraced the reforms have seen improvements in student outcomes, employability, and global competitiveness. Continued implementation and adaptation of NEP 2020's recommendations will be essential for ensuring India's position as a global educational hub by the end of this decade.

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Lung Cancer: An In-Depth Overview

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ABSTRACT

Lung cancer ranks among the most common and deadly cancers worldwide, responsible for approximately 1.8 million fatalities each year. It is primarily classified into two principal types: non-small cell lung cancer (NSCLC), which accounts for roughly 85% of cases, and small cell lung cancer (SCLC), recognized for its aggressive characteristics. The leading risk factor associated with lung cancer is tobacco use, which plays a significant role in the development of both types; however, NSCLC can also manifest in non-smokers due to factors such as genetic susceptibility and environmental influences, including exposure to radon, asbestos, and air pollution. The clinical manifestation of lung cancer is often subtle, resulting in diagnoses at advanced stages. Typical symptoms encompass a persistent cough, hemoptysis (coughing up blood), chest discomfort, and unexplained weight loss. Given the diverse nature of its presentation, diagnostic approaches frequently include imaging techniques such as chest X-rays and CT scans, followed by tissue biopsies to verify malignancy and evaluate histological types. The staging of lung cancer, which is established using the TNM classification system (tumor size, lymph node involvement, and metastasis), is essential for informing treatment strategies.

Keywords: NSCLC, SCLC, CT, Tumor, Cancer

INTRODUCTION

Lung cancer represents a major global health concern, standing as the foremost cause of cancer-related deaths [1]. This disease comprises a variety of malignancies that predominantly originate in lung tissue, classified mainly into two categories: non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC). NSCLC constitutes



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approximately 85% of all lung cancer cases and includes subtypes such as adenocarcinoma and squamous cell carcinoma. In contrast, SCLC, while less prevalent, is characterized by its rapid proliferation and aggressive nature. The principal risk factor associated with lung cancer is tobacco use, which accounts for around 85% of cases. Nevertheless, additional contributors to the risk of developing this disease include exposure to second hand smoke, radon gas, asbestos, and various environmental pollutants [2]. Furthermore, genetic factors may also influence susceptibility, as some individuals may develop lung cancer without significant exposure to established risk factors. Symptoms associated with lung cancer are often nonspecific and can manifest as a persistent cough, chest discomfort, difficulty breathing, and hemoptysis (coughing up blood) [3]. These symptoms frequently result in diagnoses at advanced stages, underscoring the importance of early detection. The diagnostic approach generally involves imaging modalities, such as chest X-rays and CT scans, followed by biopsies to confirm the presence and type of cancer [4].

MATERIALS AND METHODS

Study Population

- Individuals diagnosed with lung cancer, categorized by histological type (non-small cell lung cancer [NSCLC] and small cell lung cancer [SCLC]) and disease stage.
- High-risk groups for screening initiatives (e.g., smokers and those with a familial predisposition).

Diagnostic Tools

- Imaging Techniques: Utilization of chest X-rays, computed tomography (CT) scans, and positron emission tomography (PET) scans for preliminary assessment and staging.
- Biopsy Methods: Procedures such as bronchoscopy, fine-needle aspiration (FNA), and surgical biopsy employed to procure tissue specimens for histopathological examination.

Molecular Testing

Analysis of tissue specimens for genetic alterations (e.g., EGFR, ALK) and biomarkers to inform targeted therapeutic strategies.

Treatment Modalities

- Chemotherapeutic Agents: Utilization of drugs such as cisplatin, carboplatin, and pemetrexed, customized according to the specific cancer type.
- Targeted Therapies: Use of agents like osimertinib (for EGFR mutations) and crizotinib (for ALK rearrangements).
- Immunotherapy: Application of checkpoint inhibitors (e.g., pembrolizumab, nivolumab) in advanced disease scenarios.

Screening Methods

Implementation of low-dose computed tomography (LDCT) for individuals at high risk to facilitate early detection.

Patient Data Collection

Gathering of demographic data, smoking history, and clinical information (including symptoms and treatment responses).

METHODS

Study Design

Conducting observational cohort studies or randomized controlled trials (RCTs) aimed at assessing treatment efficacy and safety.

Patient Enrolment

- Acquisition of informed consent from participants, ensuring adherence to ethical standards and confidentiality protocols.
- Diagnostic Procedures:



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- Execution of imaging and biopsy procedures in accordance with established guidelines to verify diagnosis and staging.

Data Analysis

Statistical evaluations conducted using software tools (e.g., SPSS, R) to analyze treatment outcomes, survival rates, and inter-variable correlations.

Treatment Protocols

Delivery of chemotherapy, targeted therapy, or immunotherapy following established guidelines, with ongoing monitoring for adverse effects and therapeutic response.

Follow-Up

Consistent follow-up assessments are essential for evaluating treatment efficacy, tracking disease advancement, and identifying any adverse reactions.

Outcome Measures:

Key metrics include overall survival (OS), progression-free survival (PFS), and evaluations of quality of life (QoL) through the use of validated questionnaires.

RESULT AND DISCUSSIONS

Results and Discussions: Lung Cancer**Results****Epidemiology and Incidence:**

Lung cancer continues to be the foremost cause of cancer-related deaths, exhibiting a notably higher incidence among smokers than non-smokers. Recent research highlights that implementing screening protocols in populations at elevated risk can lead to a substantial decrease in mortality rates.

Diagnostic Advances:

Advancements in imaging technologies, particularly low-dose computed tomography (CT), have enhanced the rates of early lung cancer detection. Additionally, biopsy techniques, such as liquid biopsies, offer non-invasive alternatives for molecular characterization, facilitating more tailored treatment strategies.

Treatment Outcomes:

Chemotherapy: Conventional chemotherapy remains a viable option for both non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC), especially in later stages. Emerging evidence indicates that combination therapies may enhance response rates.

Targeted Therapies: The discovery of specific genetic mutations has propelled significant progress in treatment options. For instance, patients harboring EGFR mutations have experienced notable improvements in progression-free survival when treated with targeted therapies.

Immunotherapy: The advent of checkpoint inhibitors has revolutionized treatment approaches, with research demonstrating sustained responses in a select group of patients suffering from advanced NSCLC and SCLC.

Survival Rates:

The five-year survival rates for lung cancer remain comparatively low relative to other malignancies, largely attributable to diagnoses occurring at advanced stages. Nevertheless, early detection has markedly improved prognoses, with survival rates surpassing 70% for localized cases.

Quality of Life:

Efforts aimed at managing symptoms, providing psychological support, and promoting smoking cessation have been linked to enhanced quality of life for individuals diagnosed with lung cancer.





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DISCUSSIONS

Impact of Smoking Cessation

The strong correlation between smoking and lung cancer underscores the necessity of public health strategies focused on smoking cessation. The introduction of comprehensive smoking prohibitions and educational initiatives has demonstrated effectiveness in lowering incidence rates.

Screening and Early Detection

The implementation of low-dose computed tomography (CT) screening for populations at high risk represents a crucial advancement in early detection efforts. Ongoing investigations into the most effective screening methodologies are vital to optimize benefits while mitigating potential risks.

Personalized Medicine

Recent developments in molecular profiling are paving the way for personalized treatment strategies, which enable the customization of therapies based on specific genetic alterations. This transition towards precision oncology is essential for enhancing treatment effectiveness and reducing adverse effects.

Barriers to Treatment

Despite significant progress, inequalities in access to healthcare remain a challenge. Variables such as socioeconomic status, geographic disparities, and the availability of healthcare services can profoundly influence patient outcomes. It is imperative to address these inequalities to ensure fair cancer care.

Future Directions

Ongoing exploration of innovative therapeutic targets, combination treatment strategies, and immunotherapy will be crucial for broadening treatment alternatives. Furthermore, the early integration of palliative care and supportive services can significantly enhance overall patient quality of life.

Public Awareness and Education

Enhancing public knowledge regarding the symptoms of lung cancer, associated risk factors, and the critical nature of screening can empower individuals and promote earlier medical interventions.

CONCLUSION

Lung cancer continues to pose a significant challenge to public health, marked by elevated rates of incidence and mortality. Despite notable progress in diagnostic techniques and treatment modalities, particularly with the advent of targeted therapies and immunotherapies, the importance of early detection and preventive measures cannot be overstated. Public health strategies focused on decreasing smoking prevalence and encouraging regular screenings for at-risk groups are critical for enhancing patient outcomes. The incorporation of personalized medicine, alongside a holistic approach to patient management—which includes psychological support and palliative care—will further improve the quality of life for individuals diagnosed with lung cancer. Continuous research and interdisciplinary collaboration are essential for advancing our understanding and treatment of this intricate disease.

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Role of Nuclear DNA in Forensic Human Identification: A Review

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ABSTRACT

Forensic investigations can benefit from nuclear DNA's numerous properties, especially those related to paternal inheritance, a high copy number, and the absence of recombination. Nuclear DNA typing based on sequences of the control region or whole genome sequences analysis is used to analyze a variety of forensic evidence, including aged bones, teeth, saliva, blood, and hair, as well as other biological materials with low DNA contents. When assessing and presenting the results, it is crucial to carefully consider biological issues in addition to other ones, such as nomenclature and reference population databases. In this study, with an emphasis on forensics-related issues, we examine nuclear DNA profiling approaches for human identification and demonstrate their applicability in key human identity cases.

Keywords: Nuclear DNA, Human identification, Forensic biology, DNA Profiling

INTRODUCTION

The definition of genetic profiles allows for identifying human genetic material for forensic use. An individual's unique genomic loci is phenotypically described by their genetic profile, often known as their genetic fingerprint. Currently, only genetic profiles obtained from autosomal short tandem repeats (STR) should be used for genetic fingerprinting by international standards, particularly those of the European DNA Profiling Group (EDNAP)



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(Budowle *et al.*, 2003). Regardless of the cause of death, it is a humanitarian and even legal necessity around the world to determine the identity of the deceased. Identification can help loved ones through the grief process and, depending on the circumstances, can help with inquiries into the circumstances surrounding the death. In order to confirm the identity of the deceased, one of the four basic criteria, fingerprints, dental comparison, distinctive prosthesis, or DNA profile, is used. Each of these techniques calls for a manual examination of the remains, and in the case of DNA, it may also call for the removal of samples for more in-depth analysis or inspection (Graham, 2006).

Survey Methodology

We used PubMed Advanced Search Builder and Web of Science to systematically look for papers whose titles contained the words "nuclear DNA," "biology," "Nuclear DNA structure and genetics," "nomenclature," "sequencing," "nuclear DNA and data," "nuclear DNA and identification," and "nuclear DNA and forensic." We excluded papers that did not discuss human or animal nuclear DNA. We did not limit our search by publication date, journal or journal impact factor, authors or author affiliations.

Nuclear DNA Biology and Genetics

The majority of the genetic material in the living world today is DNA. Watson and Crick released their seminal work (Watson & Crick, 1953) on the structure of DNA just over 70 years ago. They stressed the complementarity of the base sequences on the two strands and the polymer's double-helical structure as the molecule's two key characteristics. Avery, McCarty, and Macleod's discovery that DNA was probably the "transforming principle" that allowed the transfer of genetic information between different strains of bacteria in the previous decade (Avery, *et al.*, 1944) was elegantly explained by the base sequence complementarity, with adenine complementing thymine and guanine complementing cytosine. Additionally, it supported Chargaff's key finding that the nucleotides A and T and G in double-stranded DNA are equivalent (Chargaff, *et al.*, 1951). Most crucially, the structure suggested that the data in the DNA base sequence might be able to replicate into two identical copies because of complementarity. The enormous advancements in genetic understanding and manipulation are supported by this grasp of the basic principles of genetics. However, today, the DNA characteristic that characterizes. The two strands' proximity to one another form the molecule entangled in a double helix with the right hand (deChadarevian & Kamminga, 2002). DNA is the "double helix." Despite the fact that this double-helical character is not necessary for complementarity to exist –A straightforward straight ladder construction would serve this purpose just as well because it imparts important physical information as well as chemical characteristics to the polymer. These are the characteristics that are crucial to the biological purpose of DNA. DNA's genetic features can be seen as the combination of two qualities in this way - a tape with the data store encoding the proteins, RNA molecules, and a polymer sequences double-helical string that is present and facilitates packaging accessibility and information replication store.

Although the traditional representation of a DNA molecule is a right-handed double helix, it has long been known that the molecule can take on a variety of different crucial biological shapes. These include many variants of the double helix, such as bubbles, Z-DNA, cruciforms, and slipped loops, as well as H-three-stranded DNA's triple helices and even distinctive G-quadruplexes, which are four-stranded structures (Htun & Dahlberg (1988); Harvey, *et al.*, (1998); Sundquist & Klug (1989); Kang, *et al.*, (1992); Lyamichev, *et al.*, (1985); Crawford, *et al.*, (1980); Lilley (1980); Mace, *et al.*, (1983); Minyat, *et al.*, (1995) (Figure 1).

In addition to certain sequence arrangements and base compositions, the energetic environment of these DNA sequences also favors the creation of alternate structures under physiological conditions. The DNA bubble is one of the most basic and biologically significant of these alternate forms. In this structure, strand separation happens across a brief sequence of base pairs, creating a region made up of two split strands that are surrounded by more stable double-helical stretches. Therefore, factors that encourage the unwinding of the double helix, such as greater temperatures and negative super helicity, favor melting. The distribution of preferred melting locations also closely correlates with genetic function. For instance, DNA sequences near the transcription start point and particular recombination sites are typically enriched in the TpAbase step (Drew, *et al.*, 1985). In addition to dictating bending and melting preferences, the physicochemical properties of DNA also greatly influence how eukaryotic and bacterial



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chromosomes are organized genetically. Gene coding sequences tend to be G/C-rich in nature (Struhl & Segal, 2013; Mavrich, 2008). This is partially attributable to the bias toward G/C in the codons for the most prevalent amino acids (Crick FHC, 1968; Travers A, 2006). The implication is that non coding DNA sequences, such as introns and 50 and 30 flanking DNA sequences, tend to be more A/T-rich. In fact, 30 flanking areas of the *Saccharomyces cerevisiae* genome contain the DNA sequences that are both most A/T rich and thermodynamically unstable (Travers & Muskhelishvili, 2013).

Developmental Pace of Nuclear DNA

Nuclear DNA's sluggish pace of evolution has frequently been cited as a factor limiting intraspecific research. It is well known that the rate of evolution of single-copy nuclear sequences in many vertebrates is much slower than the rate of evolution of mitochondrial DNA (Brown *et al.* 1979, 1982). This isn't a universal rule, though. It has long been known that among the three genomes that plants contain, nuclear DNA is the one that evolves the most quickly (Wolfe *et al.*, 1987). The pace of evolution of nuclear DNA is often not slower than that of mtDNA in animals other than mammals. It should be stressed that the intraspecific variability of a given DNA region may not be reflected by the substitution rate obtained from interspecific comparisons and that variability is frequently underestimated. This is because it is under the neutral or nearly neutral hypothesis of molecular evolution (Kimura, 1983; Ohta, 1992). The majority of interspecific differences between the compared taxa reflect stable differences. They only represent a small portion of all mutations that have happened because they are the result of selection and drift on mutations. Intraspecific polymorphisms, on the other hand, signify a previous transitional period in the evolution of species. Numerous or maybe most of the documented intraspecific differences are still en route to fixing or extinction. In other words, there hasn't been as much time for drift and selection to influence population genetic diversity. Therefore, intraspecific polymorphisms offer a deeper look at the actual population mutations that are occurring.

Nuclear DNA Sequencing Methods

With the exception of identical twins, everyone has a distinct genetic blueprint. The BCA employs a method known as Polymerase Chain Reaction (PCR), which enables us to make copies of specific portions of the DNA molecule, also known as Short Tandem Repeats, in order to make use of very little amounts of DNA (STRs). This allows creating a "profile" from the evidence, which may match to samples we know to have been collected from the principals in a case (Forensic Science - Nuclear DNA (mn.gov)). The first DNA sequencing methodology, also known as the chain termination method and currently referred to as first generation sequencing, was introduced by Sanger in 1977 (Sanger, Nicklen & Coulson, 1977). When ddNTPs are incorporated into freshly produced DNA strands, the elongation process is stopped, and the corresponding information about the exact nucleotide present at each point in the sequence is revealed. A maximum of 96 kb nucleotides can be read in 2 hours using the Sanger sequencing method, which can provide reads from 25 to 1200 nucleotides.

New sequencing techniques, commonly referred to as next-generation sequencing (NGS) techniques, have been created since 2005. (Bruijns, Tiggelaar & Gardeniers, 2018). Up to 80 million base pairs can be sequenced in two hours using synthesis methods like Roche's 454 Pyrosequencing and Illumina's HiSeq, or up to six billion base pairs in one to two weeks (Mascher *et al.*, 2013; Pukk *et al.*, 2015). ABI SOLiD 3plus platform hybridization and ligation sequencing generates 60 gigabases of useful DNA data each run. Sequenced DNA fragments produced by these massive parallel sequencing (MPS) technologies can be as small as 35–75 nucleotides, as in the case of the SOLiD technology (Bruijns *et al.*, 2018; Ondov *et al.*, 2010; Shendure *et al.*, 2005), or as large as 100–1,000 nucleotides, as in the case of 454 pyrosequencing (Bruijns *et al.*, 2018; Dames *et al.*, 2010). The Personal Genome Machine™ (PGM) from Ion Torrent uses a detection mechanism based on pH change when a nucleotide is added to a sequence (Rothberg *et al.*, 2011). Protons are released as a result, producing an electric signal that is inversely proportional to the number of protons released. Complementary metal-oxide-semiconductor (CMOS) sensor array chips are used to collect data; they have a sensor surface at the bottom of the well plate and can measure millions to billions of simultaneous sequencing processes (Liu *et al.*, 2014). Finally, a portable real-time sequencing technology called MinION (Oxford Nanopore Technologies) allows for extremely large read lengths (hundreds of kb), albeit having inferior accuracy (Oikonomopoulos *et al.*, 2016).



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The forensics field has aggressively adopted NGS technologies (Bruijns, Tiggelaar & Gardeniers, 2018). For instance, the PGM system from Ion Torrent has been used to examine heteroplasmy in the context of forensics (Magalhes *et al.*, 2015) and to sequence full mitogenomes (Parson *et al.*, 2013). Over the past ten years, massively parallel sequencing (MPS) has received a lot of attention. The National Cancer Institute's genetic terminology dictionary defines an MPS approach as "a high-throughput method used to determine a part of the nucleotide sequence of an individual's genome." This method makes use of DNA sequencing tools that can process numerous DNA sequences simultaneously (<https://www.cancer.gov/publications/dictionaries/genetics/dictionary>). To distinguish the new improvements from earlier DNA sequencing techniques, MPS is frequently referred to as next generation sequencing (NGS). The ideas, effectiveness, benefits, and drawbacks of NGS approaches have been covered in numerous studies (Liu *et al.*, 2014; Kircher & Kelso, 2010; Van Dijk, *et al.*, 2014; Ansorge, 2009; Kchouk, *et al.*, 2017; Zhang, *et al.*, 2011; Glenn, 2011; Shendure & Ji, 2008; Stranneheim & Lundeberg, 2012), but only a small number of papers (Yang, *et al.*, 2014; Alvarez-Cubero, *et al.*, 2017; Budowle & Schmedes, 2017) explore their use in forensic applications.

Read length, coverage, and depth are significant attributes of the various sequencing approaches. In contrast to read length, which is the actual number of sequenced bases read in one run, a read is the sequence of bases found in a single DNA molecule. The depth is the total number of reads of an area, whereas the coverage is the number of short reads that overlap inside a certain genomic region. Sequencing by synthesis is the foundation of the majority of second-generation sequencing techniques. This is the sequential extension of a primed template by an enzyme, such as SOLiD® or a polymerase (like 454). Another term that is frequently used in sequencing is homopolymer, which, in the language of the MPS, refers to a repeated DNA sequence. Homopolymer is essentially a polymer with a series of identical components. It was emphasized in the Netherlands Forensic Institute's (NFI) 2015 annual report how important it is for forensic professionals to be aware of next-generation sequencing. The University of Leiden's forensic DNA analysis lab is the first organization in the world to be accredited to employ NGS technology in this field. As a result, it is now simpler to discriminate between the many DNA profiles in a complex mixture and the likelihood of false positive matches in DNA profiling has decreased. The distinctiveness of the profiles improves with the application of NGS technology, increasing the value of the proof (i.e., lowering the chance of a random match) (https://dnadatabank.forensischinstituut.nl/binaries/dna-jaarverslag-2015_tcm37-87649.pdf). Iozzi *et al.* observed in 2015 that there have only been a few occasional pilot investigations using NGS technology in forensics (Iozzi, *et al.*, 2015). This was supported by a review of the literature conducted by Alvarez-Cubero *et al.* between December 2012 and June 2015 (Alvarez-Cubero, *et al.*, 2017). Pyrosequencing was the only method available at the time that could provide long enough reads to produce a whole DNA profile (Alvarez-Cubero, *et al.*, 2017; Van Neste, *et al.*, 2016; Børsting & Morling, 2015). 53 percent of 33 European forensic laboratories surveyed in 2017 had already purchased one or more NGS equipment. Currently, the MiSeq®/NextSeq and the Ion Torrent™ PGM™/S5 are the most popular models. Autosomal STR markers (also known as DNA profiling) and SNP markers for ancestry are two applications of next-generation sequencing technology (Alonso, *et al.*, 2017). Over the past three to five years, MPS has attracted a lot of attention by introducing new sequencing methods, methodologies, and assays. Commercially available kits for (X/Y-)STRs and SNPs for identity, biogeographical ancestry, and phenotyping applications, such as the HID-Ion AmpliSeq™ Identity (SNP) Panel (Thermo Fischer Scientific) and the ForenSeq™ DNA Signature Prep Kit (Illumina®), have been thoroughly examined by forensic researchers (Yang, *et al.*, 2014; Børsting & Morling, *et al.*, 2015; Mehta, *et al.*, 2018).

Every NGS method must be able to sequence these repetitions since STRs are utilised to generate a DNA profile that can be compared to profiles in a database (Yang, *et al.*, 2014; Børsting & Morling, 2015). More STR markers are required to enhance the likelihood of a random match, but the number of markers can only be so large using traditional analysis methods (such as PCR in conjunction with capillary electrophoresis). These restrictions do not apply to NGS approaches (Yang, *et al.*, 2014). Additionally, NGS of STR markers is ideally suited for samples with little DNA or those that have degraded (Scheible, *et al.*, 2014). NGS allows for the analysis of polymorphisms in addition to the number of repetitions (the traditional STR profile) (Alvarez-Cubero, *et al.*, 2017). Minimum nomenclature standards were established by the International Society for Forensic Genetics. For sequence variations (such as transversions, insertions, and deletions) between alleles, the conventional nomenclature for CE derived



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profiles is inappropriate (Parson, *et. al.*, 2016). Y-STRs can be used when more details regarding the paternal inheritance are needed (Yang, *et. al.*, 2014). Van Neste *et al.* used a Roche GS FLX sequencer to undertake STR-profiling because, in 2012, it was the only method that could produce the full read lengths of 400–500 bp needed for STR-profiling. The AmpFISTR® Profiler Plus® kit from Applied Biosystems was used to compare the outcomes of samples with a single contributor as well as those with many contributors. Using NGS has the advantage over conventional CE analysis in that length polymorphisms and specific sequencing polymorphism variations may both be evaluated. The assurance of paternity can be substantiated using the collected data and sufficient STR loci (Li, *et. al.*, 2017). Dropout of one or both alleles happen when annealing and/or elongation of a primer are prevented by uncommon variations in the DNA at the primer binding site. STR profiling is hampered by this condition, which is also known as null alleles or quiet alleles. Sanger sequencing was used by Yao *et al.* to identify these sequence variants at several STR loci (Yao, *et. al.*, 2018).

STRs have higher heterozygosity than single-nucleotide polymorphisms (SNPs), but they also exhibit higher mutation rates (Børsting & Morling, 2015; Wang, *et. al.*, 2015). SNPs, which include substitutions, insertions, and deletions, are single-base variations in a DNA sequence (García, *et. al.*, 2017). SNPs are employed in forensics to identify an individual's phenotypical traits and test for paternity and ancestry (using, for example, YSNPs) (Yang, *et. al.*, 2014; Grandell, *et. al.*, 2016; Hussing, *et. al.*, 2015). These indicators can provide details about ancestry, age, and appearance. A prototype instrument based on MPS that has been forensically proven will also be created for the simultaneous analysis of various DNA predictors and is appropriate for trace DNA (www.visage-h2020.eu). In order to discover new forensic marker microhaplotypes, Wang *et al.* analysed 44 loci in 2015. After that, a MiSeq® was utilized to sequence 25 loci. One microhaplotype locus has three SNPs, making it a good candidate for use as a forensic marker (Wang, *et. al.*, 2015). Elwick *et al.* investigated the inhibitory effects of humic acid, melanin, hematin, collagen, and calcium between two forensic kits, namely the HID-Ion AmpliSeq™ Library kit (Ion Torrent™ system) and the ForenSeq™ DNA Signature Prep kit (MiSeq® system). With both kits, an inhibitory effect was seen at humic acid concentrations as high as 30.3 ng/L. The ForenSeq™ kit (a kit for STRs and SNPs) was most impacted by melanin and collagen, whereas hematin and calcium showed the most inhibition with the AmpliSeq™ kit (a kit for only SNPs) (Elwick *et al.*, 2017). The HID-Ion PGM™ and the HID-Ion AmpliSeq™ Identity Panel were utilised in conjunction with the ForenSeq™ DNA Signature Prep kit and the MiSeq®. Between the two kits, there was 99.7% concordance (Apaga *et al.*, 2017). The Ion Torrent™ PGM™, in conjunction with the HID-Ion AmpliSeq™ Identity Panel, could type almost all STRs and SNPs, demonstrating that MPS is appropriate for samples with constrained availability and quality (Ambers *et al.*, 2016).

Analyzing DNA methylation (DNAm) allows for the classification of tissues and bodily fluids, estimating a person's age in years, and separating identical twins (Budowle *et al.*, 2017; Naue *et al.*, 2018). Vidaki *et al.* employed the DNA methylation level to determine a person's age. They sequenced 1156 whole blood samples from individuals ranging in age from 2 to 90 using the MiSeq® technology. Although the accuracy of the generated results was lower than that of the original model, the prediction approach can still be improved. The adoption of NGS technology has made it feasible to differentiate between DNA profiles from identical twins, which was previously impossible with the current method of STR-typing (https://dnadatabank.forensischinstituut.nl/binaries/dna-jaarverslag-2015_tcm37-87649.pdf). In under three minutes, Zaaier *et al.* have created a method for reidentifying human samples (to identify victims of catastrophic disasters or human trafficking, for example). This was demonstrated by looking at 91 SNPs in a human cell line and getting a 99.9% confidence level (Zaaier *et al.*, 2017).

Nuclear DNA in Forensic Human Identification

DNA testing can be done on bodily fluid stains and other biological tissues extracted from evidence objects. The DNA test findings from the evidence samples are contrasted with DNA from reference samples taken from well-known people. These studies could be able to link victims and suspects to one another, to pieces of evidence, or to a crime scene. On-demand, the FBI can examine samples of evidence for nuclear, Y-chromosome, and/or mitochondrial DNA. The lab uses serological testing to identify and find bodily fluids like blood and sperm on pieces of evidence.





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The most discriminating type of DNA is nuclear DNA (nDNA), which is frequently examined in samples of bodily fluids, skin cells, bones, and hairs with tissue at the root ends. The strength of nDNA testing resides in its capacity to either exclude a person as a contributor to the DNA evidence or to identify a person as the source of the DNA extracted from an item of evidence. Y-chromosome DNA testing is a type of nuclear DNA analysis that focuses just on the Y-chromosome, which is the male chromosome. Testing of this kind may be helpful in cases involving sexual assault, missing persons, and IQ. Anyone in the paternal lineage will have the same Y-chromosome profile because the Y-chromosome is passed from father to son as a complete set. Unique identifications cannot be made from Y-chromosome analysis since several relatives have the same Y-chromosome profile. The laboratory provides kinship analysis, which is a comparison carried out utilizing software to establish the potential familial relatedness between an item of evidence and a known item. As part of its work on criminal, intelligence, and missing person cases, the laboratory also does criminal paternity testing. When appropriate, DNA evidence from situations involving missing people and criminal investigations will be uploaded to the National DNA Index System (NDIS) (DNA Casework-LE (fbi.gov)). In this section, some selected published cases of human identification with nDNA are presented. Table 1 summarizes the selected published cases.

CONCLUSION

In the past 35 years, DNA testing has been widely employed throughout the world to address a variety of challenges relating to human identification in cases involving violent crimes, lesser offences, terrorism, mass disasters, and cases involving missing persons. The speed at which nDNA typing has advanced—from the days-long analysis of small fragments to the hours-long sequencing of several nDNA genomes—has been astounding. Since nDNA is a lineage genetic marker, it can reveal details about forebears' health and diseases. Even though many people would quickly admit that there are valid reasons for researchers to learn more about a potential suspect's ancestry, many still find it unacceptable that it would be possible to identify genetic predispositions to specific conditions. Therefore, given their special focus and contribution within the field of forensic human identification, emerging technologies that enable genome sequencing must be used carefully and for the purposes for which they are designed.

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Table 1: Selected published instances of nDNA-based human identification.

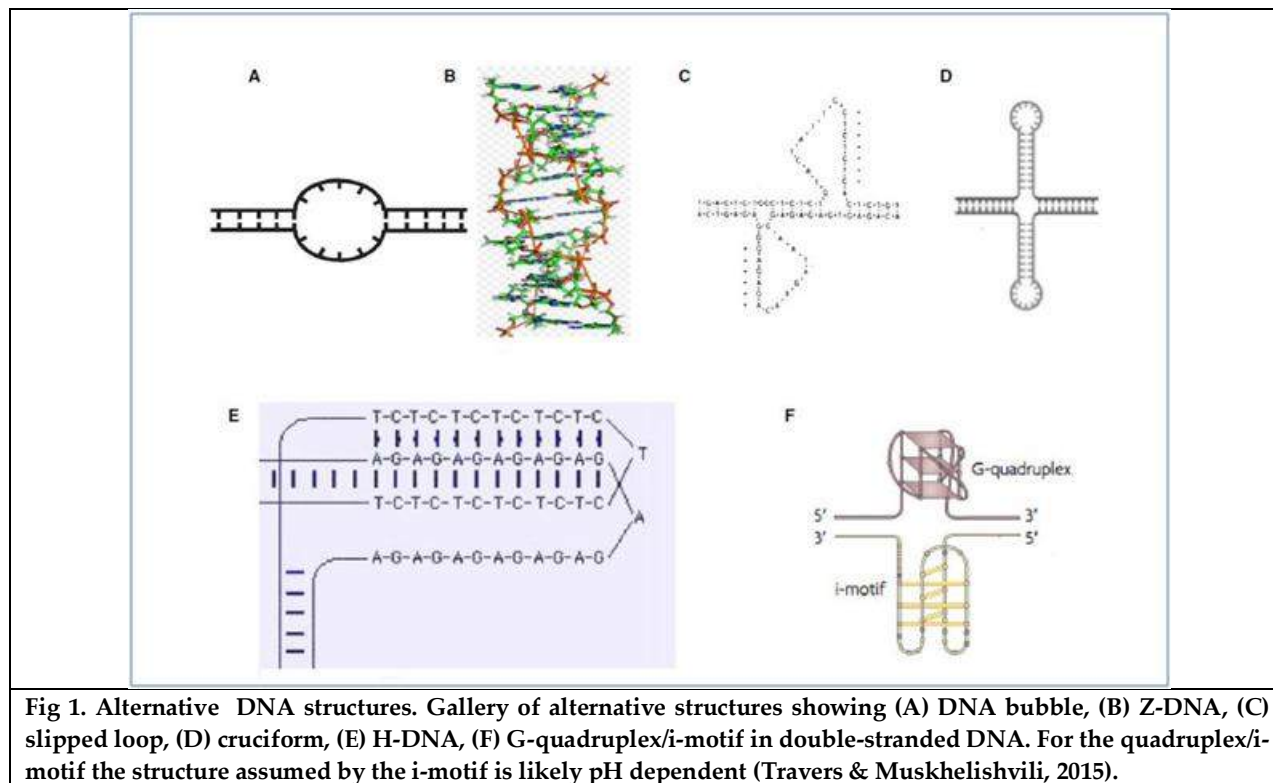
Reference / Year	Studied Sample	nDNA Studied Regions	Used Methodologies	Reference Samples	Results
M P Evison, D M Smillie, A T Chamberlain. Extraction of Single-Copy Nuclear DNA From Forensic Specimens With a Variety of Postmortem Histories (1997). <i>Journal of Forensic Sciences</i> , Volume: 42, Issue: 6. Pages: 1032-103	Human bone, teeth, and dried blood samples ranging in age from 3 months to 91 years.	The importance of the amelogenin and HLA-DPB 1 gene sequences in sexing and identification led to their selection.	PCR for amplification of HLA-DPB 1 gene and amelogenin	Not used	In 85% of situations where the donor's sex was known, amelogenin sexing was accurate.
Tillmar, A., Fagerholm, S. A., Staaf, J., Sjölund, P., & Ansell, R. (2021). Getting the conclusive lead with investigative genetic genealogy – A successful case study of a 16-year-old double murder in Sweden. <i>Forensic Science International: Genetics</i> , 53, 102525.	The first and second WGS analyses were conducted on one of the samples, referred to as "DNA extract 1," and the following two extracts were from a pool of DNA extracts from two other blood stains on the cap, referred to as "DNA Extract 2." Three blood stains from a knitted cap that was found nearby the crime scene were used to extract DNA.	For the entire WGS datasets, 1378,481 SNPs were chosen as targets.	STR analysis was performed for both "DNA Extract 1" and "DNA Extract 2", followed by massively parallel sequencing (MPS) and Whole genome sequencing (WGS).	Both the FamilyTree DNA and GEDmatch DNA genealogy databases have established and searched DNA data sets.	The results of the genealogical work produced two candidates, two brothers, one of whom standard STR profiling revealed matched the crime scene samples. At the original police hearing, the suspect admitted to the killings; he was later found guilty of the killings.
L. Pötsch; U. Meyer; S. Rothschild; P. M. Schneider; Ch. Rittner (1992). <i>Application of DNA techniques for identification using</i>	Teeth removed following dental treatment (n = 30) were kept	HLA-DQa and ApoB 3' VNTR systems from dental pulp tissue DNA	Genomic Dot Blot Identification; PCR typing of the HLA-DQa and ApoB 3' VNTR systems	Not used	The DNA extracted from tooth pulp was never appropriate for multilocus



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human dental pulp as a source of DNA. , 105(3), 139–143.	at room temperature for 6 weeks and 4 years. Additionally, teeth (n = 10) taken from jaw pieces that had been kept at room temperature for 15 years and (n = 8) taken postmortem from real identification instances were looked into.		from dental pulp tissue DNA		probe analysis.
Olaisen, Bjørnar; Stenersen, Margurethe; Mevåg, Bente (1997). <i>Identification by DNA analysis of the victims of the August 1996 Spitsbergen civil aircraft disaster.</i> , 15(4), 402–405. doi:10.1038/ng0497-402	Tissue and blood samples of all the disaster victims were collected for analysis	Three hyperpolymorphic STR loci were analysed, namely, HUMACTBP2, HUMAPOA 11 & D11S554; Five minisatellite loci, namely, D2S44, D7S21, D11S12, D5S110	PCR based marker analysis; Minisatellite analysis	Blood samples from relatives	139 cases were identified with the help of the reference samples at the rate of 98.6%
Kumar, N., & Sharma, A. (2021). Human identification through DNA analysis of teeth using powder-free method – A case study. <i>The Journal of Forensic Odontostomatology</i> , 39(1), 45–52.	Seven healthy canine and molar teeth of the deceased	Amelogenin genetic marker	PCR amplification	Blood samples of the presumed son and wife of the deceased were collected	The putative son's father was identified by amelogenin analysis, and the deceased's wife shared a chromosome with the putative son, establishing their parental relationship.



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The Role of UPI in Driving Transaction Efficiency and Revenue Growth on E-Commerce Platforms in India

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ABSTRACT

This paper aims to investigate how the Unified Payments Interface (UPI) has transformed e-commerce platforms in India by improving transaction efficiency and contributing to revenue growth. UPI, introduced by the National Payments Corporation of India (NPCI), has become the most dominant digital payment method in the country. This research explores UPI's role in driving increased transaction volumes, reducing friction in the payment process, and enhancing revenue growth for e-commerce platforms such as Amazon, Flipkart, and Myntra. Drawing on secondary data from UPI transaction reports, e-commerce growth metrics, and user feedback, this study examines how the integration of UPI into e-commerce has reshaped consumer behavior and business operations. The paper provides an in-depth analysis of UPI's impact on reducing cart abandonment rates, improving customer satisfaction, and fostering financial inclusion, particularly for small and medium-sized enterprises (SMEs). The findings highlight UPI's pivotal role in accelerating the scalability of e-commerce platforms and suggest policy recommendations for further leveraging UPI's benefits to enhance digital commerce in India.

Keywords: UPI, e-commerce, transaction efficiency, digital payments, revenue growth, consumer behaviour.





INTRODUCTION

The rise of digital payment systems has revolutionized the way businesses operate in India. Among these systems, the Unified Payments Interface (UPI) stands out as a key enabler of transaction efficiency and revenue growth in the e-commerce sector. UPI was launched in 2016 as part of the Indian government's broader Digital India initiative, aimed at promoting financial inclusion and reducing cash dependency (Agarwal & Chakraborty, 2019). The platform allows users to make seamless payments through their mobile devices by linking multiple bank accounts, facilitating peer-to-peer (P2P) and peer-to-merchant (P2M) payments. The e-commerce industry in India has witnessed unprecedented growth, partly fueled by the availability of digital payment systems like UPI. With the value of the Indian e-commerce market expected to surpass USD 200 billion by 2027, efficient and secure payment mechanisms have become indispensable (IAMAI, 2021). UPI, with its real-time transaction capabilities, has significantly influenced e-commerce by improving checkout efficiency, reducing cart abandonment, and enhancing overall user satisfaction. This paper explores how UPI's integration into e-commerce platforms has driven transaction efficiency and revenue growth, offering key insights into the system's role in reshaping India's digital commerce landscape.

LITERATURE REVIEW

The Rise of UPI in India's Digital Payment Landscape

UPI has emerged as a groundbreaking payment system, reshaping the Indian digital payment ecosystem. According to data from NPCI, UPI processed over 10 billion transactions monthly by 2023, making it the most widely used payment platform in the country (NPCI, 2023). Its success is attributed to several factors, including the ease of use, multi-bank integration, and the absence of additional charges for customers. The system supports seamless transactions that have been crucial for e-commerce platforms, where payment friction can lead to high rates of cart abandonment (Bhattacharya & Singh, 2021). UPI has also democratized digital payments in India, making it accessible to a broader population, including those in rural and semi-urban areas. This widespread adoption has been a critical factor in enabling e-commerce platforms to expand their reach to previously untapped markets. The availability of a reliable, fast, and secure payment mechanism has provided consumers with confidence in online shopping, leading to higher transaction volumes and revenue growth for e-commerce platforms (Garg & Singh, 2021).

UPI's Impact on E-Commerce Growth

The relationship between digital payment systems and e-commerce growth is well documented. Efficient payment systems are a cornerstone of successful e-commerce platforms, enabling smooth and secure transactions that build customer trust (Singh & Mehta, 2020). Historically, cash-on-delivery (COD) dominated the Indian e-commerce payment landscape due to concerns over the security of online transactions. However, COD introduced inefficiencies such as payment delays and increased return rates (Roy *et al.*, 2022). UPI has significantly reduced the reliance on COD by offering a secure and instant payment option. E-commerce platforms that have integrated UPI have reported substantial improvements in transaction success rates and reductions in cart abandonment, directly contributing to increased sales volumes (Gupta & Singh, 2021). The frictionless experience UPI provides is critical in influencing consumer behavior and increasing conversion rates.

Research Objectives

This research paper aims to address the following key objectives:

- To assess UPI's impact on the transaction efficiency of e-commerce platforms in India.
- To evaluate how UPI has contributed to revenue growth by improving customer experience and reducing cart abandonment rates.
- To explore the scalability benefits UPI offers to small and medium-sized e-commerce enterprises (SMEs).





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Research Methodology

This study adopts a quantitative approach, relying on secondary data from UPI transaction reports, e-commerce platform performance metrics, and industry reports. The analysis focuses on how UPI has improved transaction efficiency and revenue growth for key e-commerce players in India. Data on transaction volumes, cart abandonment rates, and revenue growth have been sourced from reports by NPCI, IAMAI, and RedSeer Consulting. The quantitative data is supplemented with insights from user feedback and industry surveys to provide a comprehensive understanding of UPI's role in enhancing e-commerce performance.

Analysis and Findings**UPI Transaction Trends**

UPI's growth trajectory has been remarkable, with monthly transaction volumes increasing from 93 million in 2017 to over 8.35 billion by 2023 (NPCI, 2023). This exponential growth highlights UPI's widespread adoption across both urban and rural markets in India. The integration of UPI into e-commerce platforms has been instrumental in reducing the friction typically associated with online payments, such as complex authentication processes or payment failures. The table below outlines UPI's transaction growth over the years: Table.1 The substantial growth in UPI transaction volumes is a testament to its increasing dominance in the Indian digital payment landscape. This growth can be attributed to the platform's ease of use, seamless integration with mobile applications, and the absence of transaction fees for consumers. For e-commerce platforms, UPI has become an indispensable tool for improving transaction success rates and driving revenue growth.

Impact of UPI on Transaction Efficiency

UPI has transformed the transaction experience for e-commerce users by simplifying the payment process. Traditional digital payment methods such as credit/debit cards and net banking often involved multiple steps and authentication processes, which contributed to cart abandonment and decreased conversion rates. UPI, in contrast, offers a one-click payment experience that significantly reduces transaction time and complexity. UPI's two-factor authentication and real-time transaction alerts also enhance security, further building consumer trust in e-commerce platforms. As shown in the table below, e-commerce platforms that have integrated UPI have experienced a noticeable reduction in cart abandonment rates and an improvement in overall transaction efficiency. These findings suggest that UPI not only improves the efficiency of the payment process but also enhances the overall user experience on e-commerce platforms. The reduction in cart abandonment rates can be attributed to UPI's seamless integration with e-commerce checkout systems, which minimizes the friction that often leads to incomplete purchases.

Revenue Growth and Transaction Success Rates

E-commerce platforms that have adopted UPI as a primary payment method have witnessed significant improvements in their revenue growth. UPI's ability to process transactions instantly and securely has contributed to higher transaction success rates, which in turn drives revenue. Platforms like Amazon, Flipkart, and Myntra have all reported increases in their annual revenue growth rates as a direct result of UPI's integration. The table below compares the transaction success rates of UPI with other payment methods used on e-commerce platforms: table.3 These statistics underscore UPI's superiority in terms of transaction success rates and cost efficiency. UPI's low transaction fees make it an attractive option for both merchants and consumers, especially for small and medium-sized enterprises (SMEs) operating on e-commerce platforms. The higher transaction success rates also contribute to increased consumer trust and loyalty, leading to repeat purchases and sustained revenue growth for e-commerce businesses.

Scalability Benefits for SMEs

One of UPI's most significant contributions to the e-commerce ecosystem is its ability to support the scalability of small and medium-sized enterprises (SMEs). UPI's low transaction costs, combined with its ability to handle high transaction volumes, make it an ideal payment solution for SMEs looking to expand their online presence. UPI has democratized access to digital payments for small merchants and rural consumers, enabling them to participate in



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the digital economy. As a result, SMEs have been able to increase their sales volumes, reduce operational costs, and improve customer satisfaction through faster payment processing and refunds. The table below highlights the key scalability metrics for SMEs that have integrated UPI: Table.4 These findings demonstrate that UPI has significantly enhanced the scalability of SMEs by providing a cost-effective, reliable, and efficient payment mechanism. By integrating UPI, SMEs can process a higher volume of transactions with minimal costs, enabling them to scale their operations more effectively.

DISCUSSION

UPI's Contribution to E-Commerce Efficiency

UPI's integration into e-commerce platforms has undoubtedly improved transaction efficiency, both from a consumer and business perspective. The speed of transaction processing, combined with UPI's low failure rates, has streamlined the payment process, making it easier for consumers to complete purchases. This efficiency is particularly beneficial during peak shopping periods, such as festive seasons and online sales, where transaction volumes are significantly higher. For businesses, UPI's ability to handle large transaction volumes without incurring high transaction fees has provided a competitive advantage. E-commerce platforms can process more transactions in less time, leading to increased sales and revenue growth. Additionally, UPI's real-time payment notifications allow businesses to process orders faster, reducing delays in delivery and enhancing customer satisfaction.

Revenue Growth and Scalability Implications

The revenue growth observed on e-commerce platforms that have integrated UPI is a direct result of the payment system's efficiency and reliability. By reducing the friction associated with online payments, UPI has encouraged more consumers to shop online, leading to higher transaction volumes and repeat purchases. Furthermore, UPI's scalability benefits have enabled SMEs to grow their online businesses by reducing operational costs and improving customer retention. The future potential of UPI in e-commerce is vast, particularly as new features like UPI Lite and UPI 123Pay are introduced, which will further enhance its usability for rural and feature phone users. These innovations will likely drive even greater adoption of UPI, leading to sustained revenue growth for e-commerce platforms in India.

CONCLUSION

This research has demonstrated that UPI has played a pivotal role in driving transaction efficiency and revenue growth on e-commerce platforms in India. By offering a fast, secure, and cost-effective payment solution, UPI has transformed the digital payment landscape, benefiting both consumers and businesses. E-commerce platforms that have integrated UPI have seen significant improvements in transaction success rates, reduced cart abandonment, and increased revenue growth. Moreover, UPI's scalability benefits have been particularly advantageous for SMEs, allowing them to expand their online presence and reach new customers. As UPI continues to evolve, its potential to further enhance the e-commerce sector is undeniable. Policymakers and businesses should continue to support the development of UPI to maximize its impact on India's digital economy.

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Table.1 outlines UPI's transaction growth over the years

Year	Monthly Transaction Volume (in billions)	Monthly Transaction Value (INR trillion)	Annual Growth Rate (%)
2017	0.09	0.1	-
2018	0.62	1.2	568%
2019	1.3	2.9	110%
2020	2.21	3.9	70%
2021	4.53	7.5	105%
2022	6.78	9.8	50%
2023	8.35	12.0	23%

Source: NPCI Annual Report, 2023

Table.2 : Impact of UPI on Transaction Efficiency

Platform	Annual Revenue Growth Rate (%)	Increase in Order Volume (%)	Transaction Frequency Growth (%)
Amazon India	28%	12%	18%
Flipkart	30%	15%	20%
Myntra	22%	10%	15%
Snapdeal	18%	8%	14%

Source: RedSeer Consulting, 2023





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Table.3 compares the transaction success rates of UPI with other payment methods used on e-commerce platforms:

Payment Method	Transaction Success Rate (%)	Merchant Fee (%)	Consumer Preference (%)	Cart Abandonment Reduction (%)
UPI	99%	0-0.5%	67%	5-10%
Credit/Debit Card	90%	2-3%	23%	2-3%
Digital Wallet	85%	1-2%	10%	1-2%
Net Banking	88%	0.5-1%	20%	3-5%

Source: NPCI, 2023; RedSeer, 2023

Table. 4 Highlights the key scalability metrics for SMEs that have integrated UPI

Metric	Impact of UPI	Source
Increase in Sales Volume	18% increase in sales volume for SMEs	Ernst & Young, 2022
Reduction in Costs	22% reduction in operational costs for SMEs	PwC SME Report, 2022
Adoption Rate	60% of small merchants in rural areas adopting UPI	Statista Digital Payments Study, 2023





Unlearnt Lessons from Chemical Industrial Accidents

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ABSTRACT

Chemical Industrial accidents have become a casual affair today. Every week, there is an accident observed in small scale or medium or in a major industry. In fire cracker and mining industries it became a regular matter. In spite of a systematic study and strategic mechanisms being under taken still they are occurring at regular intervals. In this paper, the causes of accidents were discussed, types of accidents, places of occurring and case studies were presented right from Bhopal gas tragedy till to LG polymers some examples were quoted, In the changed circumstances and of living standards some more precautions need to be taken were also presented, ethical values need to be taught to the work force, frequent stress relieving measures were suggested. Mobile phone utility beyond the limits, intoxicants consumption are to be avoided

Keywords: Industrial Accidents, strategic mechanisms, Bhopal gas tragedy, stress relieving, intoxicants

INTRODUCTION

The "Bhopal Gas Tragedy," the worst chemical (industrial) disaster in history, occurred in India in 1984[1]. The most catastrophic chemical disaster in history occurred at the Bhopal Gas tragedy, when the poisonous gas Methyl Iso Cyanate (MIC) was unintentionally released, killing thousands of people. According to government data, a deficiency in fundamental safety protocols results in the death of three workers in Indian industries every day on average. The Labor Ministry reported to Parliament in 2021 that during the previous five years, 6,500 workers had lost lives at ports, mines, factories, and construction sites. About 30% of the nation's fire-related fatalities occurred in





Maharashtra and Gujarat. 3. India ranks third in the world for fire incidents according to the 2018 India Risk Surveys. Burst gas cylinders continue to cause One-Fifth of Fire Accidents in India. Fireworks, cooking gas cylinder/stove bursts, electrical/short circuits, and other factors are the four main causes of fire incidents, according to the NCRB[2]. Riot and agitation-related incidents have also been reported since 2014. Even with these categorizations, "other factors" are still cited as the cause of over 60% of fire incidents. Gas cylinder explosions are a major contributing factor, accounting for, on average, one-fifth of all fire incidents in India. Out of 7,566 occurrences in 2022, 1,567 were linked to short circuits, and 1,551 cases were linked to gas cylinder explosions. Gas cylinder burst fire accidents decreased from 27% to 20% during the same period, but the percentage of fire accidents brought on by electrical problems or short circuits increased from 3% in 1996 to 21% in 2022. Over the past eight years, five states have accounted for three-fourths of all fire accidents. A state-by-state breakdown of fire incidents in India indicates that the numbers are dominated by a small number of states. Madhya Pradesh, Maharashtra, Gujarat, Karnataka, and Tamil Nadu accounted for more than 75% of all fire accidents between 2014 and 2022. With an average of 23%, Madhya Pradesh [3] was in first place, followed by Maharashtra (19%), Gujarat (13%), Karnataka (12%), and Tamil Nadu (10%). Although determining the precise causes of this concentration is difficult, the larger cases of fire accidents in these states is probably influenced by variables like urbanization and industrialization. India has to completely revamp its fire safety regulations. Both recent and historical fire disasters have brought to light serious flaws.

In recent past, LG polymers, Visakhapatnam accident occurred due to Styrene leakage also because of lack of SOP awareness by workers[4],[5],[6]

The Probable reasons for Accidents:

1. Mistakes by industrial personnel
2. Improper training and awareness
3. Failure to check regular functioning of machinery
4. Financial and family stress of workers
5. No knowledge of Risk Assessment and hazard Identification
6. No knowledge Toxic materials Identification and handling
7. Lack of Communication and Coordination
8. Unaware of Safety procedures
9. Management and work force lethargy
10. Lack of attention due to OT

Three-Fourths of Fire Accidents concentrated in five states over last Eight Years

The state-wise analysis of fire accidents in India reveals that a few states dominate the statistics. Between 2014 and 2022, Madhya Pradesh, Maharashtra, Gujarat, Karnataka, and Tamil Nadu collectively accounted for over 75% of all fire accidents. Madhya Pradesh led the tally with an average of 23%, followed by Maharashtra at 19%, Gujarat at 13%, Karnataka at 12%, and Tamil Nadu at 10%. On May 07, 2020. At about 3 a.m. on May 7, 2020, styrene monomer vapour had leaked out of a storage tank on the premises of LG Polymers unit located at Venkatapuram village on the outskirts of the Port City. The dangerous vapour, which spread over 3 km, had left 12 persons, who included two children, dead. Nearly 600 people were hospitalized with chest tightness and visibility issues.

CONCLUSION

Accidents in the workplace can have serious repercussions for organizations and people. Manufacturers can considerably lower the risks connected with workplace mishaps by learning about the nine most frequent causes of industrial accidents and putting the necessary preventive measures in place. A safer and more efficient manufacturing sector will result from placing a high priority on risk assessment, employee well-being, equipment maintenance, safe work environments, effective communication, and adherence to safety rules. Stress relieving

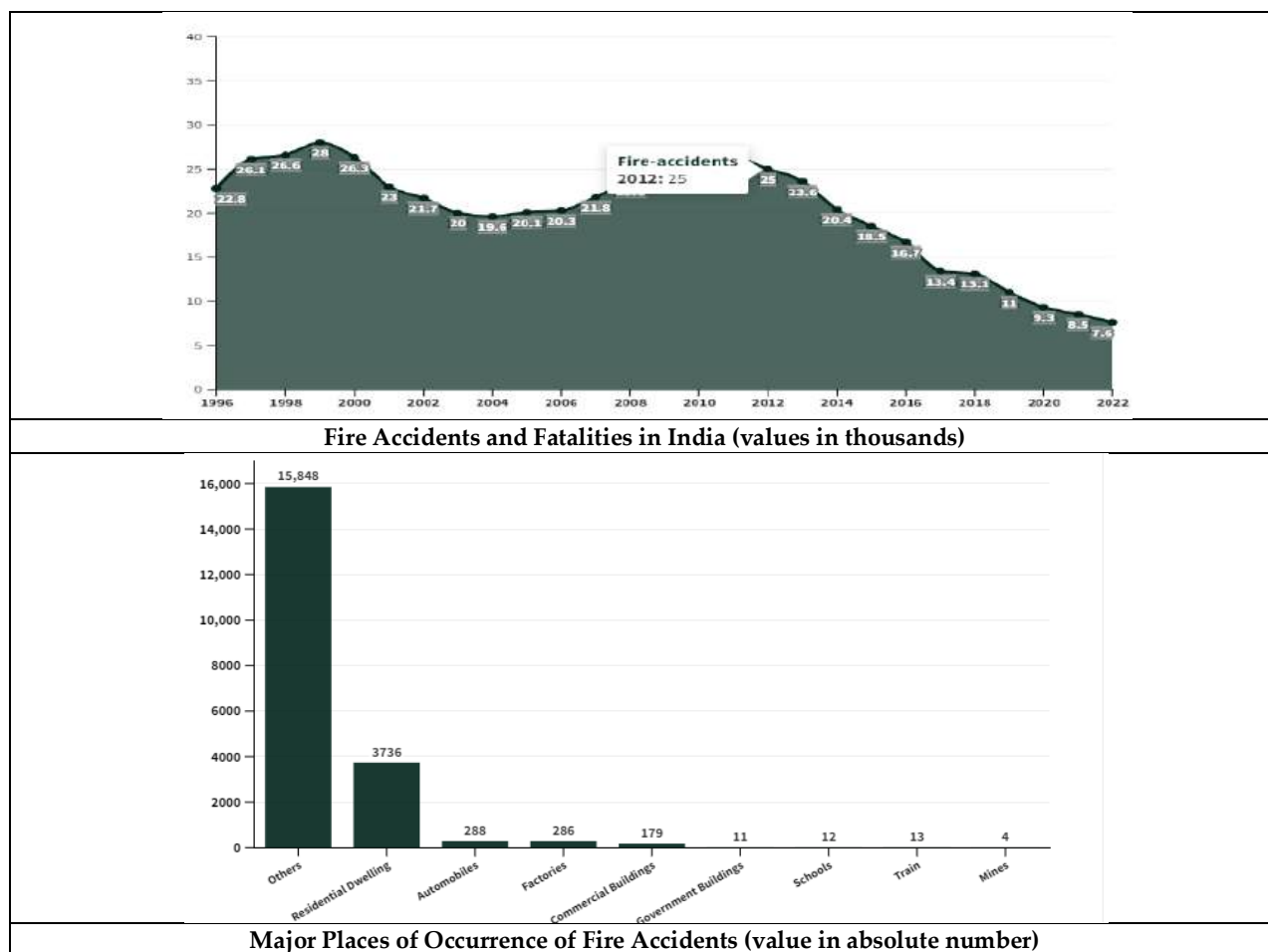


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through spiritual methods if applied, it gives the best results. Frequent check up of workers, supervisors with Alcohol meters is also suggested for minimizing the accidents

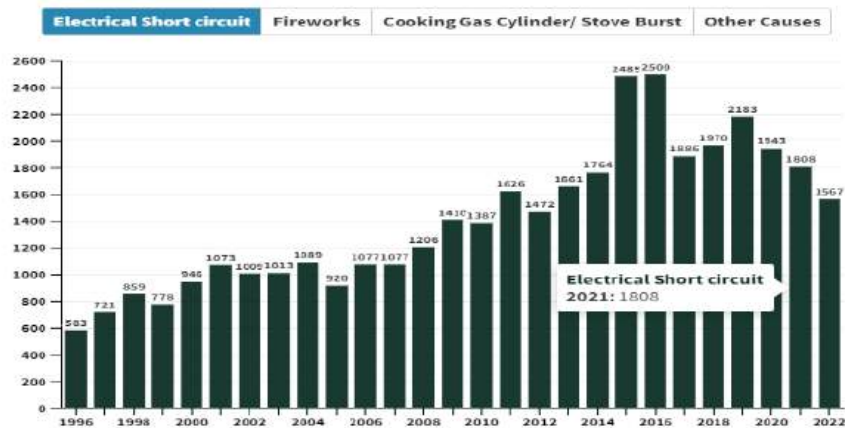
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LG POLYMERS Industry-Visakhapatnam



LG Polymers unit, in Visakhapatnam





Revolutionizing Knowledge Management: The Role of Emerging Technologies

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ABSTRACT

The rise of new technologies, including artificial intelligence (AI), blockchain, augmented reality (AR), big data, and the Internet of Things (IoT), has fundamentally transformed conventional knowledge management (KM) systems. These advancements are changing the ways in which knowledge is captured, structured, disseminated, and applied within organizations. This paper investigates the significant impact of these technologies on improving the efficiency and effectiveness of KM practices. Innovations such as AI-enhanced knowledge discovery, the secure decentralized nature of blockchain, and the immersive training capabilities of AR are among the developments that are redefining the KM landscape. By analyzing various case studies and technological implementations, this research article offers a thorough examination of how emerging technologies facilitate organizational learning, collaboration, and decision-making. Additionally, the paper highlights the challenges and strategies for effectively incorporating these technologies into current KM frameworks. Ultimately, the interplay between technology and KM presents substantial opportunities for driving innovation, nurturing a culture of knowledge sharing, and gaining a competitive advantage in the digital age.

Keywords: Knowledge Management (KM), Knowledge Sharing, Knowledge Transfer, Artificial Intelligence (AI), Blockchain, Internet of Things (IoT), Augmented Reality (AR), Virtual Reality (VR), Big Data, Machine Learning (ML), Emerging Technologies, Data Security





INTRODUCTION

Knowledge management (KM) is an essential organizational practice that emphasizes the generation, preservation, dissemination, and utilization of knowledge to enhance decision-making, foster innovation, and boost organizational performance. Recent technological developments have significantly transformed the landscape of knowledge management. Innovations such as artificial intelligence (AI), blockchain, augmented reality (AR), virtual reality (VR), and the Internet of Things (IoT) are propelling a new era of KM advancements. This paper examines the influence of these technologies on KM, providing insights into their potential to streamline knowledge processes, improve collaboration, and facilitate more informed decision-making. The advent of these cutting-edge technologies enables organizations to transcend conventional KM methods, which typically depended on static documentation and manual workflows. In contrast, AI, big data, and IoT offer dynamic, real-time functionalities that empower organizations to adapt more rapidly to market fluctuations, enhance their learning environments, and achieve a more profound comprehension of their knowledge ecosystems, both internally and externally.

Objectives

This article seeks to deliver a comprehensive examination of the impact these technologies have on transforming Knowledge Management (KM), as well as the potential benefits and obstacles related to their adoption. The structure of the paper is as follows:

1. Artificial Intelligence (AI) in Knowledge Management
2. Blockchain for Secure Knowledge Sharing
3. Augmented Reality (AR) and Virtual Reality (VR) for Knowledge Transfer
4. Big Data Analytics in Knowledge Management
5. The Role of Internet of Things (IoT) in KM Integration
6. Challenges and Strategies for Integrating Emerging Technologies into KM
7. Future Trends and Opportunities in Knowledge Management

Each section will examine specific use cases, benefits, and challenges associated with adopting these technologies in the realm of knowledge management.

Section 1: Artificial Intelligence (AI) in Knowledge Management

Artificial Intelligence has become a significant disruptive element in Knowledge Management, providing improved data processing abilities, automation, and tailored experiences. This section will examine the role of AI systems in streamlining knowledge discovery, overseeing content management, and delivering customized insights to employees.

AI-Enhanced Automation in Knowledge Discovery:

Artificial Intelligence plays a pivotal role in streamlining the knowledge discovery process, significantly minimizing the time and resources needed to analyze extensive datasets. Conventional knowledge management systems typically depend on manual data entry and fixed databases, which can be labor-intensive and susceptible to human mistakes. In contrast, AI is capable of examining both structured and unstructured data, pinpointing pertinent information, and presenting it in a manner that facilitates informed decision-making. Machine Learning algorithms have the ability to learn continuously from the data they analyze, thereby enhancing the precision of knowledge discovery over time. For example, Natural Language Processing (NLP) empowers AI systems to comprehend and extract information from various sources such as documents, emails, and transcripts. This functionality allows AI to aid in revealing essential insights, recognizing patterns, and even forecasting future knowledge requirements. By leveraging AI, organizations can not only retrieve relevant knowledge more swiftly but also ensure that the information is applicable and tailored to the specific needs of the user.

The Role of AI in Customized Knowledge Distribution

AI significantly enhances knowledge management (KM) by facilitating the delivery of customized knowledge. By analyzing user interactions, preferences, and work habits, AI technologies can offer tailored knowledge suggestions



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that align with individual requirements. This approach ensures that employees access pertinent information quickly, minimizing the time spent navigating extensive knowledge databases.

AI-Powered Chatbots and Virtual Assistants:

AI-driven virtual assistants and chatbots are frequently employed to offer immediate knowledge assistance. These tools can respond to inquiries, locate documents, and recommend resources in real time, enabling employees to obtain the information they need without interrupting their workflow. The capacity to customize knowledge delivery makes KM more focused on user needs and boosts overall productivity.

Section 2: Blockchain for Secure Knowledge Sharing

Blockchain technology offers a decentralized and secure framework for the management of knowledge assets, guaranteeing the preservation of data integrity and trust. Blockchain offers several key advantages for knowledge sharing:

Security

- **Data Integrity:** The cryptographic methods used in blockchain ensure that once information is recorded, it remains unchangeable without the agreement of the network, safeguarding the reliability of shared knowledge.
- **Access Control:** Users can precisely manage who can view their information, improving the confidentiality and security of sensitive data.

Transparency

- **Immutable Record:** Each transaction or update is transparently logged, allowing all users to track the history of knowledge contributions and changes.
- **Trust Building:** Enhanced transparency helps build trust among collaborators, as they can confirm the authenticity of the shared information.

Traceability

- **Audit Trail:** Blockchain creates a complete and verifiable record of who contributed knowledge and when, promoting accountability.
- **Version Control:** Tracking changes and contributions is straightforward, helping to avoid disputes over authorship and ensuring proper recognition.

Decentralization

- **Elimination of Single Point of Failure:** Distributing knowledge across a network reduces the risks tied to centralized systems, such as data breaches or loss of information.
- **Empowerment:** Individuals can share knowledge directly, eliminating the need for intermediaries and fostering collaboration and innovation.

Enhanced Collaboration

- **Smart Contracts:** Agreements related to knowledge sharing can be automated using smart contracts, which execute automatically when certain conditions are met.
- **Incentive Mechanisms:** Blockchain can support token-based systems that reward contributors for sharing valuable insights, encouraging participation.

Cost Efficiency

- **Reduced Transaction Costs:** By cutting out intermediaries and simplifying processes, blockchain can decrease the expenses tied to knowledge sharing and management.
- **Efficient Resource Allocation:** Organizations can make better use of resources by accessing a decentralized knowledge base without needing extensive infrastructure.



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- **Collaborative Platforms:** Blockchain can lead to the development of decentralized platforms for knowledge sharing, driving innovation and new ideas through collective intelligence.
- **Global Reach:** Improved accessibility allows for knowledge sharing across different geographical boundaries, bringing in diverse perspectives and solutions.

Section 3: Augmented Reality (AR) and Virtual Reality (VR) for Knowledge Transfer

The integration of Augmented Reality (AR) and Virtual Reality (VR) in knowledge transfer significantly enhances learning by utilizing immersive technologies. These tools make intricate information more engaging, accessible, and memorable. Here are some ways these technologies support effective knowledge transfer:

Immersive Learning Environments

- **AR:** By superimposing digital information onto the real world, AR enables learners to grasp abstract ideas through real-time visualization. For instance, medical students can examine 3D representations of organs within their actual surroundings, allowing for interactive exploration.
- **VR:** VR constructs fully virtual settings, immersing learners in experiences that are challenging, hazardous, or costly to recreate in reality. In fields like technical training, VR can replicate machinery operations, providing a safe environment for trainees to practice.

Increased Engagement and Motivation

- Both AR and VR foster greater learner engagement by shifting from passive to interactive learning experiences. Incorporating gamification elements, such as challenges or tasks within AR/VR settings, keeps learners motivated and attentive.
- The immersive quality of these technologies enhances focus, leading to improved retention of complex subjects.

Engaging Learning Experiences

- **AR:** AR enhances the physical world by adding digital elements, enabling learners to visualize complex concepts in real-time. For example, medical students can interact with 3D models of organs in their actual environment, facilitating a deeper understanding.
- **VR:** VR immerses learners in completely virtual environments, allowing them to experience scenarios that are impractical, risky, or costly to recreate in reality. In technical training, VR can simulate the operation of machinery, providing a safe space for practice.

Collaborative Learning

- **AR:** Augmented Reality tools in education promote collaborative learning by allowing multiple users to engage with the same augmented materials. This approach encourages dialogue and collective learning experiences.
- **VR:** Virtual classrooms and group simulations create opportunities for learners in various locations to engage in a unified environment. VR enhances distance education by making it more interactive, replicating the advantages of in-person collaboration.

Tailored and Personalized Learning

- Both AR and VR can customize educational experiences to meet individual learner needs. For instance, students can engage with content at their own speed, revisit difficult topics, or modify the difficulty level according to their comprehension. Adaptive learning technologies can track user performance and offer personalized feedback or challenges, thereby enriching the overall educational experience.

Cognitive Benefits

- **Spatial Learning:** VR and AR excel in facilitating spatial learning, enabling learners to grasp the relative positions, movements, and interactions of objects. This is particularly beneficial for architects and designers, who can visualize structures in three dimensions, thereby enhancing their spatial reasoning and creativity.



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- **Memory Retention:** Research indicates that immersive learning through AR and VR can significantly boost memory retention by linking knowledge to experiences, making it easier to recall information compared to conventional learning methods.

Access to Otherwise Inaccessible Resources

- **Virtual Field Trips:** VR allows learners to explore locations that would otherwise be unreachable, such as historical landmarks, outer space, or the ocean's depths, thus providing experiential learning opportunities.
- **AR for Remote Learning:** Augmented Reality can introduce objects, models, or entire simulations into a learner's home or workspace, enabling remote or distant learners to gain practical experience without the need for physical presence.

Training for High-Risk Professions

- **Emergency Services:** Firefighters, law enforcement officers, and military staff can benefit from virtual reality simulations designed to prepare them for hazardous or high-pressure situations. These immersive experiences mimic actual scenarios, allowing them to refine their decision-making skills and operational procedures in a controlled yet realistic setting.
- **Medical Simulations:** Surgeons and other healthcare practitioners can utilize virtual reality to conduct simulated surgeries, providing an opportunity to make and learn from errors without any real-life repercussions.

Section 4: Big Data Analytics in Knowledge Management

Big data is providing KM systems with the ability to analyze vast volumes of structured and unstructured data, revealing new insights that can inform decision-making and innovation.

- **Predictive Analytics for Knowledge Utilization:** Big data allows organizations to predict future trends and behaviors based on historical data, optimizing the use of knowledge assets.
- **Real-Time Analytics:** Advanced analytics offer real-time insights into operational efficiency, helping organizations make informed, data-driven decisions.

Section 5: The Role of Internet of Things (IoT) in KM Integration

The Internet of Things (IoT) is producing vast quantities of data that can be incorporated into knowledge management (KM) systems, leading to improved decision-making and process efficiency.

- **Knowledge Acquisition through IoT:** IoT devices have the capability to autonomously gather and relay information from the surrounding environment, thereby enhancing situational awareness and facilitating better decision-making.
- **Immediate Data for Informed Decisions:** By merging IoT with KM systems, organizations gain access to real-time operational insights, which support proactive decision-making and effective problem resolution.

Challenges and Strategies for Integrating Emerging Technologies into Knowledge Management

The integration of emerging technologies into knowledge management systems presents a variety of challenges, despite the advantages they offer. This section will examine these obstacles and propose strategies to address them, including ensuring compatibility of data, tackling privacy issues, and equipping employees with the necessary training.

Future Trends and Opportunities in Knowledge Management

The evolution of knowledge management will be significantly influenced by the ongoing advancements in emerging technologies. Innovations such as AI-enhanced decision-making, blockchain-based decentralized knowledge systems and immersive environments for collaboration and training using AR/VR are on the horizon. This section will explore potential future trends and the opportunities they create for improving organizational knowledge practices.



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CONCLUSION

Emerging technologies are transforming the landscape of knowledge management by introducing new tools and capabilities that enhance the processes of knowledge discovery, sharing, and application. The automation potential of AI, the secure sharing mechanisms of blockchain, the immersive training possibilities of AR/VR, and the real-time data integration offered by IoT are all contributing to significant advancements in KM systems. By adopting these technologies, organizations can cultivate more agile, responsive, and innovative knowledge ecosystems. However, to fully harness the benefits of these innovations, companies must strategically address integration challenges and align their approaches with specific knowledge management objectives. The future of KM hinges on the successful combination of human expertise and technological advancements, fostering a collaborative atmosphere that encourages ongoing learning and development.

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Impact of Electro Magnetic Radiation on Human life

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ABSTRACT

Electromagnetic waves permeate contemporary culture. They occur when individuals utilize electrical energy, electronic security systems, and other wireless communication technologies. Despite the diversity of physical characteristics and abilities across many domains, they all elicit apprehensions among individuals who may encounter health issues. It is widely recognized that strong fields can induce rapid physiological effects, such as burns, while exposure limitations and laws effectively mitigate these effects. The present concern centers on the notion that extended exposure to weak fields may adversely affect health due to an undetermined biological mechanism. The widespread application of these methods and the considerable exposure to specific key domains suggest that even a minor link with sickness risk could substantially impact public health.

Keywords: Electromagnetic exposure, Global Warming, Environment, CT scan, MRI scan, Plant cells, DNA.





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INTRODUCTION

Electromagnetic radiation (EMR) is a form of radiation that propagates in waves and encompasses both electric and magnetic fields. Both natural and synthetic sources contribute to it. The energy levels of electromagnetic radiation can vary from low to high. It comprises X-rays, gamma rays, infrared radiation, visible light, ultraviolet radiation, radio waves, and microwaves (Figure-1). An electric field accelerates a charged atomic particle, such as an electron, resulting in the emission of electromagnetic radiation. Electric and magnetic fields are generated during motion, oscillating and propagating perpendicularly to one other. Waves possess distinct features, which can be articulated as frequency, wavelength, or energy. The correlation between electromagnetic fields and human health has been extensively studied, however certain questions remain unresolved. Public concern regarding potential health risks associated with exposure to electromagnetic fields is exacerbated by unsolved issues. These challenges affect risk management and the public's acceptance of scientific risk assessments. Public anxiety may arise from several anxiety-inducing events and is exacerbated by a deficiency of understanding regarding electromagnetic fields, which are omnipresent in our environment yet imperceptible to sight or touch. The situation may be further worse by media coverage, which often relies not on a comprehensive evaluation of the scientific evidence underpinning a recognized public health issue, but rather on sensationalized reports of certain research that capture public interest. Electromagnetic fields may exert biological effects on human cells, potentially disrupting cellular processes and resulting in negative health outcomes. A distinction must be made between the biological effects of electromagnetic fields and health problems resulting from such fields. This distinction is crucial to risk assessment, as any consequence is pertinent only if it may be deemed potentially harmful to health [1]. Although there is a broad comprehension of the biological impacts of electromagnetic energy, considerable knowledge needs to be acquired about its long-term health ramifications.

In this context, three primary uncertainties require thorough examination: (1) whether electromagnetic exposure constitutes a health risk, (2) which aspects of the exposure contribute to health effects (e.g., frequency ranges, time-weighted averages, or exposures exceeding specific thresholds), and (3) the severity of the health effects. Expert assessments about these three uncertainties differ significantly. Opinions vary from a firm belief, grounded in physical reasoning, that electromagnetic radiation does not provide a health danger, to a belief, supported by epidemiological studies, that it may significantly elevate the incidence of some malignancies by two- or thrice. Performing a formal risk analysis seems futile given the extensive array of perspectives [1]. Organizations that establish safety standards must navigate conflicting expectations. One must protect against the risks of disease and harm for both the employee and the public. Facilitating access to practical technologies for the broader populace is another objective. The degree to which these potentially conflicting objectives are achieved depends on several factors, including the public's and regulators' comprehension of the dangers, the technology's value, and the public's perceived control over their exposure to it. The primary inquiry is whether the existing electromagnetic safety standards are sufficient to protect public health. These requirements are substantiated by scientific data about the thermal effects of electromagnetic radiation. It is scientifically contentious whether exposure beneath the safety threshold levels may adversely affect health [3]. The scientific literature indicates a lack of sufficient data to establish a link between electromagnetic fields below safety thresholds and adverse health effects. Moreover, several recent studies have evaluated the scientific evidence on potential health risks from electromagnetic exposure below the safety threshold and concluded that no such risk has been substantiated [4–7]. The findings, however, vary regarding the extent and significance of difficulties in the scientific comprehension of this subject. It is essential to recognize that the health effects may not become apparent until years of exposure have elapsed. Demonstrating "evidence of risk" or "proof of safety" that can be maintained "beyond all reasonable doubt" within a few years for chronic diseases such as cancer is tough.



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DISCUSSION

Our Protective Atmosphere

The electromagnetic radiation emitted by the Sun, a source of energy across the entire spectrum, incessantly bombards our environment. The Earth's atmosphere protects us against exposure to certain harmful high-energy waves. The term "ionizing" pertains to waves possessing sufficient energy to remove electrons from atoms. Examples of these waves include gamma rays, x-rays, and certain ultraviolet waves. These highly intense waves have the capability to alter molecules and atoms, as well as damage the cells of living stuff. The modifications to cells resulting from radiation used to eradicate cancer cells might occasionally be advantageous. At other times, however, they are unable to do so, particularly when we suffer from sunburn. The gases in Earth's atmosphere that predominantly reflect or absorb electromagnetic radiation include ozone, carbon dioxide, and water vapor. Visible light predominantly transmits via the atmosphere. The phrase "atmospheric windows" denotes specific segments of the spectrum that allow wavelengths to propagate through the atmosphere. The optimal wavelength for transmitting satellite communication signals is microwave, as certain frequencies can penetrate clouds. The atmosphere, essential for protecting life on Earth and ensuring the planet's habitability, is not very beneficial for investigating the sources of high-energy radiation in space. To observe higher energy and some lower energy light sources such as quasars, sensors must be situated above Earth's energy-absorbing atmosphere.

Benefits of Electromagnetic Radiation

EMR pertains to nanotechnology research, investigating natural phenomena and their applications. Future advancements in this field of study will profoundly influence both biomedical engineering and medicine. Magnetic nanoparticles are the most discussed topics in the domains of life sciences and medicine. The highly effective cellular damage induced by magnetic hyperthermia is examined. Furthermore, the application of electromagnetic radiation (EMR) facilitates magnetic hyperthermia, which utilizes magnetic nanoparticles to generate heat remotely. Cancer patients undergo treatment utilizing this hyperthermia heating technique. Recent advancements in cancer treatment methodologies have been achieved through the use of EMR. Treatment modalities encompass chemotherapy, immunotherapy, radiation therapy, and hormone therapy. Ultraviolet light from the sun harms healthy skin cells while simultaneously facilitating the destruction of cancer cells. Organ visualization is conducted for cancer patients during therapy with X-rays and gamma rays. Regular application of radiation therapy may be detrimental to the body. In practical practice, recurrent exposure to these examinations and therapies correlates with an increased risk of cancer development.

Disease Diagnosing Using Electromagnetic Radiation

Imaging modalities such as radiography, angiography, and computed tomography utilize electromagnetic radiation. Various radiographic imaging procedures. The present study concluded that angiography offered a comprehensive visualization of the body's blood vessels and many organs, including the cardiac chambers, arteries, and narrow veins. The inaugural modern imaging technique was X-ray computed tomography (CT), developed in 1972. It is employed to acquire sub-millimeter isotropic pictures of the complete body within 5 to 20 minutes. Phase-contrast X-ray imaging is an excellent technique for analyzing intricate characteristics in biological soft tissues. This approach allows visualization of the three-dimensional structure of infected tissues. Synchrotron radiation micro-tomography is employed for analyzing the composition and internal structure of diverse materials and biological specimens. Magnetic resonance imaging (MRI) is an excellent technique for obtaining accurate internal images of the human body. It is utilized to diagnose several diseases and conditions impacting the human body, including cardiovascular disease, occluded blood vessels, neoplasms, vascular damage, cerebral injury, and spinal cord injury. An electromagnetic actuator was developed for magnetic resonance electrography (MRE). The actuator is notable for its user-friendliness, portability, and capability to record images of the brain, abdomen, and phantoms. The actuator system is applicable in diverse clinical studies due to its simple installation procedure and uncomplicated design.





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Earth's Radiation Budget

The Earth's radiation budget comprises the energy that the Earth system receives, reflects, absorbs, and emits. The principle of energy conservation dictates that the radiation budget accounts for the equilibrium between incoming radiation, predominantly solar, and outgoing radiation, which comprises solar radiation reflected from the Earth's surface and radiation emitted by the entire ecosystem, including the atmosphere. An unbalanced budget may ultimately affect our climate by altering atmospheric temperatures. The Earth's climate system is predominantly influenced by the Sun's incoming shortwave radiation, encompassing ultraviolet, visible, and a minor quantity of infrared energy. This incoming radiation is partially reflected by clouds, partially absorbed by the atmosphere, and partially transferred to the Earth's surface. The atmosphere heats due to the interactions between bigger aerosol particles and the radiation they absorb. Long wave infrared radiation, a portion of which escapes into space, is generated when this absorption results in heat. Solar radiation that penetrates Earth's atmosphere is either reflected by snow, ice, and various surfaces or absorbed by the planet's surface. Absorbed incoming shortwave radiation results in the emission of heat as long wave radiation. The warmer higher atmosphere emits energy into space, in addition to a little amount of radiation from the Earth's surface. The lower atmosphere is heated by the predominant long wave radiation emitted, thereby warming the Earth's surface.

Effect of Radiation on Green House Effect

The predominant portion of the long wave infrared radiation emitted by the Earth is absorbed by atmospheric greenhouse gases, including water vapor and carbon dioxide, thereby heating the lower atmosphere. The elevated temperature subsequently emits long wave radiation, a portion of which reaches the Earth's surface, maintaining warmth and overall comfort. Global warming, or more generally, global climate change, results from an elevation in the concentration of greenhouse gases such as carbon dioxide and methane, which elevate the temperature of the lower atmosphere by restricting the escape of radiated energy.

Effects of Electromagnetic Fields on Environmental Degradation

Recent studies on the effects of electromagnetic fields (EMF) on the environment have predominantly focused on extremely low frequency (ELF) fields, particularly those generated by overhead power lines. Their primary emphasis was on plants instead of animals that would likely be among the most vulnerable to EMF. Historically, research has mostly focused on the presence or absence of observable symptoms (endpoints), such as a reduction in pollen fertility. These findings are rather straightforward to comprehend; nevertheless, they may not reflect more nuanced impacts at low exposure levels. Recent research have utilized more sensitive tissue or blood testing to get insights into certain biological processes through the use of biomarkers.

For example, they have quantified

- The concentration of antioxidants in the bloodstream.
- Substances that signify stress, such as alanine in plants and heat shock proteins in animals.
- Alterations in the development of specific plant cells.
- Alterations in DNA.

The testing demonstrated the capability to detect alterations at low field strengths, which are more consistent with those typically found in the environment. Comprehending them in relation to species and ecological health is more challenging. Regrettably, these strategies have not explicitly focused on the species expected to be the most vulnerable to EMF. Duckweed exhibited a buildup of alanine when exposed in the laboratory to low-intensity magnetic fields that fluctuated over time at extremely low frequencies (ELF). Various forms of stress are accompanied by the stress indicator referred to as alanine accumulation, which may be elucidated by the generation of free radicals from the magnetic field. Low-frequency electromagnetic fields were observed to affect snails both in laboratory settings and beneath overhead power lines. The authors assert that the generation of free radicals by low-frequency electromagnetic fields is responsible for the effects seen. The authors observed effects on DNA and cellular components. However, no damage to the snails' external appearance was noted. The synergistic effects of electromagnetic fields and many environmental conditions have been examined in multiple studies on plants. The impact of EMF exposure from a GSM phone, in conjunction with calcium deficiency, on flax seedling growth, or the effects of EMF mixed with UV-B radiation on cucumber seedling growth. This research raises the question of the



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practicality for individual plants and ecosystems if the influence of EMF compounds the effects of other environmental conditions.

Effect of Electromagnetic Radiation on Plants

Minimal radiation levels promote plant growth, however excessive radiation levels are detrimental. Photosynthesis requires non-ionizing radiation, such as sunshine, which is vital for plants. Although specific solar radiations are vital for plant survival, various other ionizing and non-ionizing radiation types are detrimental to plants. The extent of damage is inversely related to the quantity of UV radiation received, influencing plant growth and germination. Radiation exposure can lead to soil compaction and nutrient depletion, both of which are vital for plant growth. Elevated radiation dosages administered to plants were determined to be highly detrimental in laboratory experiments utilizing filtered lamps to provide UV light. Radiation impairs stomatal resistance. The leaf of the plant contains a little aperture known as a stomata, which regulates water levels. Stomata near to conserve water during increased evaporation caused by intense radiation. The plant's growth is constrained if the stomata remain closed for a lengthy duration. Prolonged exposure to radiation can completely obliterate the stomata, ultimately resulting in the plant's demise.

Chromosomes, the genetic constituents of plants responsible for reproduction, are located within plant cells. If radiation inflicts substantial damage to the cellular membrane, reproduction is impeded. The chance of mutations increases due to cell death triggered by UV exposure. Affected plants often exhibit weak, diminutive, and altered leaf patterns. Prolonged radiation exposure can completely devastate a plant's fertility, leading to its gradual decline. The environment can also be toxic and may impede the growth of future offspring. The mechanisms by which strong radiation exterminates plants differ. Their varying sizes and chromosomal numbers are the primary reasons for this discrepancy. Sparrow asserted that, unlike plants with an abundance of small chromosomes, those with fewer chromosomes present a more substantial target for radiation exposure.

Effects of Electromagnetic Radiation on Biotic Systems

Electromagnetic radiation affects animals, birds, plants, and other biotic beings. Compared to humans, the effects of EMR are typically more significant in avian species, such as sparrows, pigeons, and bees. The rationale is because avian anatomical structures are diminutive and less dense than those of mammals. They frequently overheat, and the radiation they absorb can damage their navigational system.

Effects of Electromagnetic Radiation on Birds

Honey bee populations near cell phone towers suffer adverse effects from electromagnetic radiation. Several years prior, a correlation was identified in the US between the sudden decline of bee populations and a rise in electromagnetic radiation pollution. Colony collapse disorder (CCD) refers to a phenomenon of honey bee death, characterized by bees' inability to identify their colony due to persistent electromagnetic radiation pollution. Numerous developing nations, like Italy, Spain, Germany, and England, have experienced the proliferation of CCD. Migratory birds entirely lose their navigational abilities and sense of direction upon direct exposure to electromagnetic radiation from television, cellular phones, and FM towers. Numerous migratory avians, such as sparrows and pigeons, experience disorientation due to interference from mobile phone towers. The convergence of television, mobile phone, and FM towers globally during migration results in the extinction of several bird species annually. Birds are thought to utilize the Earth's magnetic field for navigation. Nocturnal avian accidents are predominantly attributed to the confounding microwaves emitted by cellular devices. The population of house sparrows in London has significantly declined since 1994, with migratory species such as sparrows and pigeons adversely affected by interference from mobile phone towers. The intersection of television, cellular, and FM towers globally during migration results in the extinction of several avian species annually. Birds will presumably utilize the Earth's magnetic field for navigation. Microwave radiation from communication resources may induce significant disorientation.



**Santhi Priya et al.,****Effect of Electromagnetic Radiation on Animals**

The term "radiation" generally encompasses all forms of electromagnetic radiation, such as light and radio waves; nevertheless, it predominantly pertains to ionizing radiation, a high-energy form capable of ionizing atoms, generated during the decay of radioactive isotopes. Ionizing radiation includes X-rays, gamma rays, alpha particles, and beta particles, among others. They possess the capacity to jeopardize the health of both humans and animals if present in sufficiently high concentrations. Gamma rays and X-rays possess significant energy due to their position at the uppermost end of the frequency spectrum. A photon of gamma or X-ray radiation conveys its energy to its target upon colliding with an electron or another particle. This energy transfer can ionize or displace electrons from atoms, thereby disrupting chemical bonds between them. High-energy particles, referred to as alpha and beta radiation, are released by the decaying nuclei of unstable isotopes. Although they are more readily attenuated than X-rays and gamma rays, they possess an even greater ability to ionize atoms and disrupt chemical bonds. Polonium-210 is a radioactive isotope that emits alpha particles. Ionizing radiation can either destroy or form new chemical bonds when impacting an animal cell. The alterations in molecules and their specific modifications influence the cell to differing extents. DNA damage is especially detrimental as mutations to cellular DNA over time may lead to cancer.

Cells may endure a specific extent of damage due to intrinsic repair mechanisms. Nevertheless, an animal cell will perish if exposed to sufficient ionizing radiation or if the damage is sufficiently severe. Animals may perish at elevated doses. A single radioactive dosage of one rad or more is classified as an acute dose, whereas repeated exposure to low doses over a longer duration is deemed chronic exposure. Acute exposure inflicts the most significant damage on rapidly dividing animal cells. Cells in the bone marrow, lymphatic tissue, and the rapidly proliferating cells of the mammalian gastrointestinal tract are especially susceptible. Significant radiation exposure can lead to fatigue, anemia, internal hemorrhage, gastrointestinal issues, irreversible infertility, and potentially death. Prolonged exposure can irrevocably harm cellular DNA, potentially resulting in cancer. Given that mice have been included in numerous radiation experiments, it is likely that the effects on mice have been studied most extensively.

The fundamental effect of radiofrequency electromagnetic waves is the heating of biological tissues. Short-term exposure to exceptionally high levels of electromagnetic fields can undoubtedly have adverse health effects. Electromagnetic fields influence the body's metabolic processes and exert various biological effects on cells through multiple mechanisms. The absorption of significant electromagnetic energy can modify the body's electric current, thereby disrupting the chemical structures of tissue. Compared to other forms of non-ionizing radiation such as visible light and infrared, RF radiation possesses lower energy, however it is more energetic than ELF radiation. RF radiation can generate heat when absorbed by the body in adequate amounts. This may cause tissue damage and burns.

Effect of Electromagnetic Radiation from Mobile Phones

The cell phone has become an essential component of contemporary life. In recent years, mobile phones have emerged as a vital element of society, commerce, and education. Mobile phones are crucial instruments in emergencies and facilitate rapid information dissemination. Excessive mobile phone use may lead to eye and hearing complaints among the public, hence increasing social awareness of health-related concerns. The hippocampus lipidome disrupts our brain and central nervous system. We ought to restrict our daily mobile phone usage for calls, refrain from using them in areas with weak signal strength, and maintain distance from our bodies.

Effect of Wi-Fi on Environment

The present study investigated the beneficial and detrimental impacts of electromagnetic radiation induced by Wi-Fi. Rapid network connectivity is facilitated by Wi-Fi LANs, which are especially beneficial since they save wiring installation costs and provide industrial users with increased flexibility regarding the location and timing of their operations. Residential consumers also wish to bypass the wire installation process. Wireless Internet routers or Wi-Fi modems transfer signals to your computer through barriers utilizing potentially harmful electromagnetic



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radiation. The presence of a wireless Internet router in your residence or workplace will result in exposure to electromagnetic radiation (EMR). Alzheimer's disease may be induced by extended exposure to Wi-Fi radio frequency (RF) waves at a specific absorption rate (SAR) of 1.60 W/kg for two hours daily over the course of one month. Exposure to EMR (2.45 GHz) may lead to several alterations in the brain, including a reduction in brain antioxidants. The proximity of a wirelessly connected laptop to the lap near the testicles may impact male fertility and increase DNA fragmentation.

Safety Guidelines in Telecommunications Sectors

Scientific research indicates that electromagnetic radiation from telecommunication towers may adversely affect humans, avian species, wildlife, and the ecosystem over extended periods. Recommendations are proposed to mitigate the long-term effects of EMR, including advising network operators to employ reduced cumulative power densities in proximity to residential, commercial, medical, and other densely inhabited areas. Individuals should recognize the enduring implications of electromagnetic radiation dangers. The diminished transmission strength may result in network issues, especially for individuals residing far from the cell tower; yet, it will be advantageous for their overall health. The installation of many low-power FM, TV, and cellular towers is the resultant solution. The tower's energy efficiency will be compromised as a consequence. Consequently, the thermal impact on health will be mitigated.

Safety Precautions against Electro Magnetic Radiation

Government, scientists, and industry must implement effective research and policy measures to address concerns about the potential health risks of electromagnetic energy, considering the extensive debate and differing perspectives, especially regarding public health and environmental protection. Such behaviors may encompass:

- Regular reassessment of the potential health concerns linked to electromagnetic fields when new, impartial research findings emerge to enhance confidence in a scientifically grounded risk appraisal.
- Comprehensive disclosure of information regarding electromagnetic emissions from all pertinent sources, accompanied by transparency.
- Public access to the latest research on the impact of electromagnetic fields on biology and health. Scientific risk assessment that incorporates non-technical variables, including cognitive, emotional, and socio-demographic predictors of risk.
- Conduct comprehensive risk assessments and research efforts capable of revealing both positive and negative consequences, with the aim of effectively conveying these findings to all stakeholders.
- Public participation in risk management activities addressing concerns regarding the potential health hazards of electromagnetic fields.
- Assessment of the impact of preventive measures on public apprehension and the implementation of voluntary or mandatory policies.
- Engagement in a suitable discourse regarding the varying levels of scientific uncertainty with individuals and groups.

CONCLUSION

Individuals globally have confronted the health concerns arising from the prolonged impact of electromagnetic radiation from telecommunication and biomedical gadgets. Organizations such as the World Health Organization (WHO), Federal Communication Commission (FCC), and International Commission on Non-Ionizing Radiation Protection (ICNIRP) have proposed various safety measures to safeguard all living organisms. Experimental approaches have demonstrated that the prolonged effects of EMR may lead to many illnesses in live organisms. Despite widespread awareness of the long-term ramifications of EMR dangers, individuals may lack the option to migrate if cell phones, television, and FM towers are constructed in proximity to their residences, educational institutions, public transportation centers, hospitals, and similar locations. However, there is contention surrounding





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the matter. EMR significantly advantages from advancements in biological and communication technologies. Consequently, we cannot cease utilizing these radiations. Researchers will endeavor to uncover potential solutions, which may incur significant costs. Nevertheless, we can effectively mitigate the health risks for all organisms, including humans, animals, and birds.

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Table-1: Different types of electromagnetic waves

S. No.	Type of Radiation	Frequency Range (Hz)	Wavelength Range
1	Gamma-rays	$10^{20} - 10^{24}$	$< 10^{-12}$ m
2	X-rays	$10^{17} - 10^{20}$	1 nm – 1 pm
3	Ultraviolet	$10^{15} - 10^{17}$	400 nm – 1 nm
4	Visible	$4 \times 10^{14} - 7.5 \times 10^{14}$	750 nm – 400 nm
5	Near IR	$1 \times 10^{14} - 4 \times 10^{14}$	2.5 μ m – 750 nm
6	IR	$10^{13} - 10^{14}$	25 μ m – 2.5 μ m
7	Microwaves	$3 \times 10^{11} - 10^{13}$	1 mm – 25 μ m
8	Radio waves	$< 3 \times 10^{11}$	> 1 mm

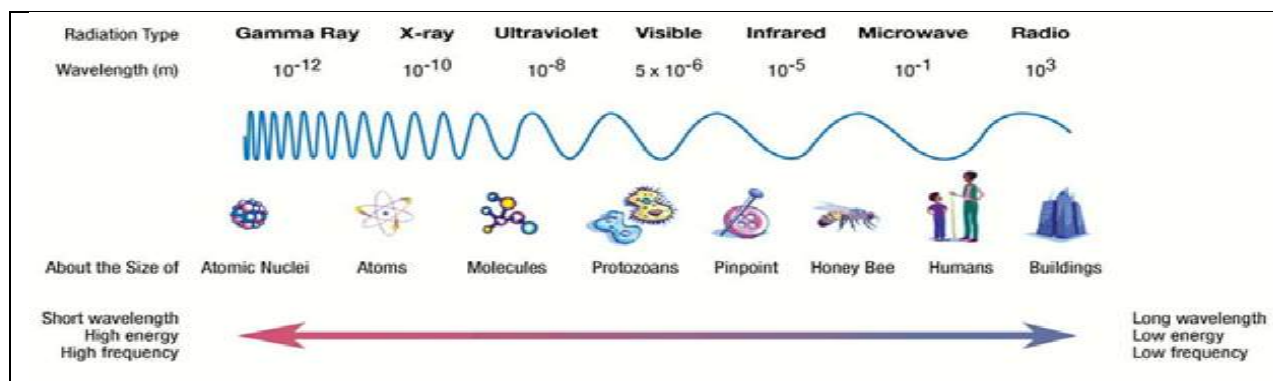


Figure-1: Types of Electromagnetic Radiation



Figure-2: Effect of Radiation on Earth



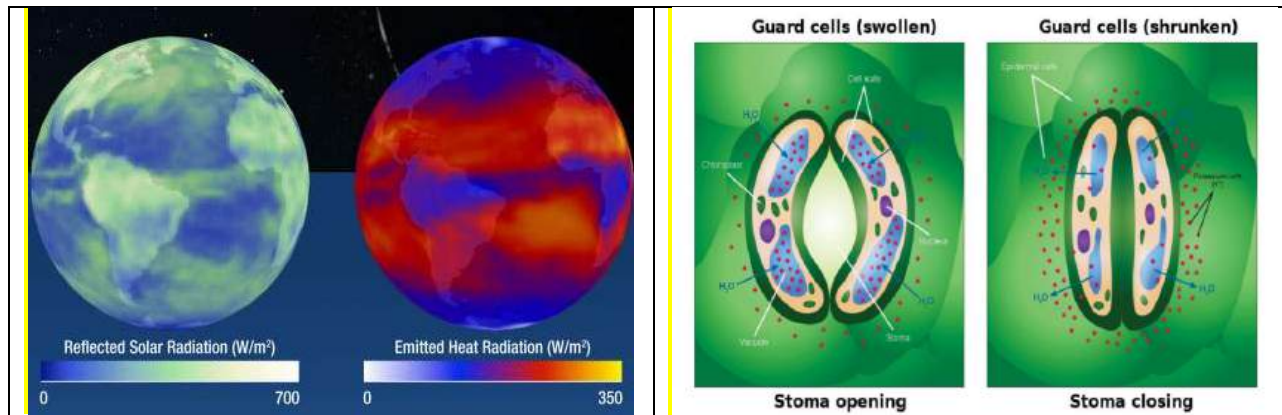


Figure-3: Effect of heat radiation on global warming

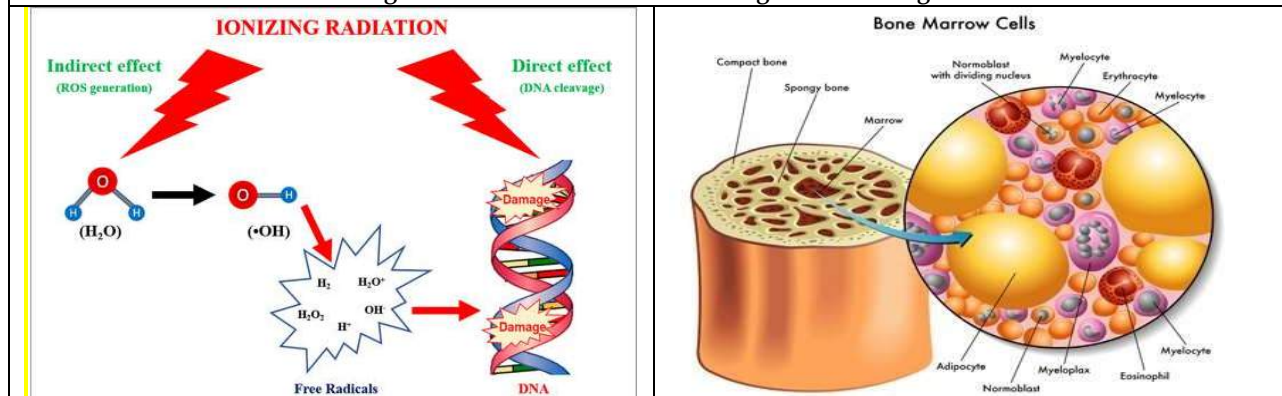


Figure-4: Process of Ionization Radiation

Figure-5: Bone marrow cell diagram



Figure-6: Effect of Electromagnetic radiation on Human brain

Figure-7: Effect EMR on Human reproduction system





Deep Learning based Model for Visual Fault Classification of Photo Voltaic Panels

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ABSTRACT

Photovoltaic (PV) systems have produced an unprecedented amount of electricity in the last few decades. However, the amount of energy produced has significantly decreased due to a number of environmental conditions, most notably the buildup of dust on PV panels. Numerous techniques, such as deep learning, machine learning, sensors, IoT-enabled cameras, thermal imaging, and image processing, are being investigated to decrease power loss and detect dust. In order to identify dust deposition on solar panels, a modified convolutional neural network (CNN) architecture was used in this study. This model's 86.43% accuracy is superior to other algorithms that are currently in use when its performance is compared. Future study can use the suggested model as a standard. Additionally, the model's performance can be further improved by modifying its hyperparameters, and the dataset can be enlarged for multiclass classification.

Keywords: CNN; image processing; photo voltaic; dust decomposition; PV visual faults

INTRODUCTION

Humanity has long been captivated by renewable energy. In light of the challenges posed by global warming and the depletion of fossil fuel supplies, it is imperative to find a dependable and sustainable energy source. Future cities may rely more on renewable energy sources for their primary energy supply instead of fossil fuels with a carbon foundation. Integrating clean renewable energy sources is more important than ever in light of the world's rapidly urbanizing population in order to reduce environmental damage and promote sustainable population growth in the ensuing decades. As a result, installations of renewable energy, including as solar, wind, and geothermal facilities,



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have increased significantly in recent years. This change is most noticeable in the increasing preference for electricity over fossil fuels. Solar, wind, and hydro energy are the primary renewable energy sources, with solar energy offering numerous advantages, such as longer lifespan, environmental benefits, quiet operation, and cleanliness. Photovoltaic (PV) cells are a promising solar technology, capable of directly converting sunlight into electricity with a nominal efficiency of 15% to 20%. However, the global expansion of solar energy is limited by this relatively low efficiency, and optimal performance is influenced by several environmental factors, such as the PV surface's dust accumulation, operating temperature, wind speed, shade, hail, snow, air density, and sky conditions [1]. Among these, dirt, dust, and other particles cause soiling losses, which drastically lower PV module efficiency.

Several factors can contribute to a reduction in power generation from solar panels [2], including: (1) Solar panels convert sunlight into electricity, so less sunlight results in less electricity. This can occur on cloudy days, during winter, or in areas with high air pollution levels, (2) Solar panels operate most efficiently at moderate temperatures. Excessive heat reduces efficiency because higher temperatures cause electrons in the solar cells to move faster, decreasing the energy converted into electricity, (3) Dust, dirt, and debris can obstruct sunlight from reaching the solar panels, leading to reduced electricity output. Regular cleaning is necessary to maintain optimal performance, (4) Over time, solar panels naturally degrade, which diminishes their efficiency. The rate of degradation depends on the type of panel and the environmental conditions where it is installed, (5) An essential component in producing power is the inverter, which changes the direct current (DC) generated by solar panels into the alternating current (AC) utilized in residences and commercial buildings. If the inverter fails, the solar panels won't supply power.

The efficiency of solar panels is reduced and the amount of energy produced is decreased when dust, snow, bird droppings, and other material accumulate on them. For solar panels to continue operating at their best, maintenance and cleaning are therefore necessary [3][15]. Improving the modules' performance, reducing maintenance costs, and conserving resources all depend on creating an efficient monitoring and cleaning process. The goal of this study is to investigate the efficacy of several machine learning classifiers in accurately identifying physical and electrical problems, dust, snow, bird droppings, and other concerns on solar panel surfaces.

A unique method for dust detection was introduced by Abuqaoud *et al.* [4] based on computer vision and image processing methods. Their methodology comprised using a co-occurrence gray level matrix in conjunction with the hue layer from the HSV color space to extract features for the purpose of classifying panels classified as clean or filthy using a linear approach. Tribak *et al.* [5] investigated the usage of both digital and infrared cameras for increased accuracy in order to further progress dust detection systems. Artificial intelligence (AI)-based dust detection techniques have recently advanced and gained popularity, offering a new angle on the topic [6]. Researchers have used a variety of methods to identify dust particles: In order to identify dust particles, Maitre *et al.* [8] employed random forest classification; Igathinathane *et al.* [7] measured the diameters of dust particles from high-resolution photos using computer vision; and Proietti *et al.* [9] classified and detected dust on solar panels using k-nearest neighbors (k-NN). A convolutional neural network (CNN) method for dust recognition was proposed by Mehta *et al.* [10]. The data was featured using bi-directional Input-Aware Fusion, and the soiling classes were classified using web-supervised learning based on the impact area of dust obtained from projected localization masks. A deep belief network was created in a different study to identify dust on photovoltaic panels, and it outperformed other machine learning models in terms of accuracy [11]. Additionally, a study combined the MobileNet and VGG-16 CNN methodologies for solar panel evaluation with the physical lotus effect methodology, which makes solar panel maintenance easier [12].

The creation of a CNN architecture designed exclusively for dust detection on solar panels is the aim of this endeavor. It also looks at how well the machine learning classifier performs in identifying dust, snow, bird droppings, and electrical and physical problems on solar panel surfaces with the highest degree of accuracy. To verify the efficiency of the suggested model, it is evaluated and contrasted with the most recent techniques. There are multiple sections to this article. CNN-based techniques for dust detection are covered in Section 2. The experimental



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setup and necessary parameters are described in Section 3. The results analysis and discussions are presented in Sections 4 and 5. In conclusion, Section 6 presents a summary of possible avenues for future research.

MATERIALS AND METHODS

Data Resources

A useful resource for researching the use of deep learning techniques for surface anomaly detection on solar panels is the dataset given in [14]. With a total of 875 photos showing different surface conditions as demonstrated in Table 1 and Fig. 1, it is meant to address the negative effects of external conditions on solar panel performance, such as dust accumulation, snow covers, bird droppings, and both physical and electrical damage. Every type of surface condition in the dataset is organized into a different class folder.

Proposed Model

A model trained on one job can serve as the foundation for a separate model utilized for a different job through a machine learning technique called transfer learning. This is especially helpful if there is little data available for the second task or if there are certain commonalities between the two activities. Convolutional neural network (CNN) VGG16 was trained using the ImageNet dataset, which has 1,000 classes and over 14 million images. It's a highly capable model that can achieve cutting-edge results in various image classification challenges[16]. To implement transfer learning with VGG16, we can load the pre-trained model from the Keras library. Usually, we use our own dataset to train the last layers after freezing the weights of the initial layers. This strategy allows us to leverage the knowledge VGG16 acquired from the ImageNet dataset while customizing the model for our specific task. Using transfer learning with VGG16 can be an effective method for developing machine learning models with limited data. It can also enhance the performance of a model even when ample data is available, especially if that data is noisy or imbalanced.

A convolutional neural network (CNN) that is frequently used for image categorization is called VGG16. VGG16, which was unveiled in 2014 by the University of Oxford's Visual Geometry Group (VGG), has 16 layers and has shown to be incredibly successful in picture categorization applications. It has demonstrated cutting-edge performance on multiple benchmark datasets, such as ImageNet. Many image classification tasks, including object recognition, scene classification, and human identification, can be handled by it. VGG16 [13] achieves excellent performance on multiple benchmark datasets while maintaining a high level of accuracy. It is appropriate for real-time applications due to its architecture, which is reasonably efficient.

An input image with a fixed size of 224×224 RGB is fed into the suggested model in Figure 2. Our sole preprocessing involves subtracting the mean RGB value from each pixel that we calculated from the training set. Subsequently, the image is passed through a series of convolutional (conv.) layers using filters with a 3×3 tiny receptive field, the smallest size capable of capturing left-to-right, up-and-down, and center relationships [17]. Furthermore, in one configuration, we employ 1×1 convolution filters, which serve as a linear modification of the input channels prior to non-linearity. For 3×3 convolution layers, pixel-by-pixel padding is used to preserve the spatial resolution of each convolution layer's input. One is the fixed convolution stride. Spatial pooling is achieved via five max-pooling layers, which are arranged after some but not all of the conversion stages. Max-pooling is performed over a 2×2 -pixel window with a stride of two. Three Fully-Connected (FC) layers follow a sequence of convolutional layers, the depth of which vary depending on the specific design. There are 1,000 channels in the third FC layer of total one for each class is in charge of 1,000-way ILSVRC classification, while the first two FC levels each have 4,096 channels [18]. The final layer is a SoftMax layer. The fully connected layers are set up uniformly across all networks.





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RESULTS AND DISCUSSION

This section presents and discusses the experimental results. First, when the proposed model was validated on the test set, its performance was assessed. The performance was then visualized using a confusion matrix. Lastly, a comparison was made between the outcomes and the most recent models. Accuracy and precision were the evaluation metrics that were applied. We use this method to compute the mean accuracy on the test set in order to assess how well our suggested model performs. For all five of the cross-validation folds, the loss and accuracy are displayed versus the number of epochs in Figure 3. Additionally, it shows that the accuracy had stabilized after the 50 epochs of training, which prevented over fitting. The test pictures' confusion matrix for our model, which functions as an error matrix to show the model's performance. The ground truth examples are represented by each column in this matrix, while the projected class instances are represented by each row. This makes it simple to determine whether and to what extent two classes are confused by the model. With the confusion matrix displayed in percentage form, it is easier to understand the model's accuracy and any misclassifications.

A balanced dataset is essential for efficient model training. The dataset's applicability for upcoming machine learning and deep learning classification tasks was indicated by its constant performance when trained with state-of-the-art models, demonstrating its viability [19]. After that, the suggested model was used on this dataset, and with just 56 million parameters, it produced a high accuracy of 86.43%. When compared to existing models, VGG16 outperformed them in key evaluation metrics. Additionally, it yielded better results compared to similar studies, such as Maity *et al.*'s CNN LeNet model, which achieved 80% accuracy, and Zyout *et al.*'s Alex-Net model, which reached 83.3% accuracy for dust detection only.

The accuracy of the proposed model was significantly higher than that of the most sophisticated models. In the context of our problem, the number of trainable parameters is less crucial, but it is still vital for calculation speed. Even though the model has less trainable parameters, its performance thus demonstrates that accuracy is the most important feature in this situation.

CONCLUSION

The creation of a CNN model with the ability to identify surface defects on solar panels is the main objective of the suggested model design. The suggested CNN model, which has three thick layers, convolutional-pooling pairings, and 56 million trainable parameters, was developed using the publicly available online dataset. This model minimizes the number of trainable parameters, which lowers computational complexity. Even with this decrease, the model proved to be highly usable; in the multiclass categorization of images over 50 epochs, it achieved an accuracy of 86.43% across five folds. Using test data, cross-validation further validated the model's efficacy. Future work can enhance the dataset by including classes for various types of dirt on solar panels, such as dust, dust mixed with rain, water stains, and more. Additionally, by compiling images from throughout the globe, the dataset may be increased and models for multi-class categorization might be created. As the suggested model is a customized CNN model, adjustments can always be made. It may be possible to further increase accuracy while lowering loss and computing complexity by experimenting with changes to hyperparameters like the optimizer and activation function.

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Table 1. Details of database used

Different classes	No. of images	Classification labels
Bird drop	191	0
Clean	192	1
Dusty	194	2
Electrical damage	104	3
Physical damage	70	4
Snow-covered	124	5

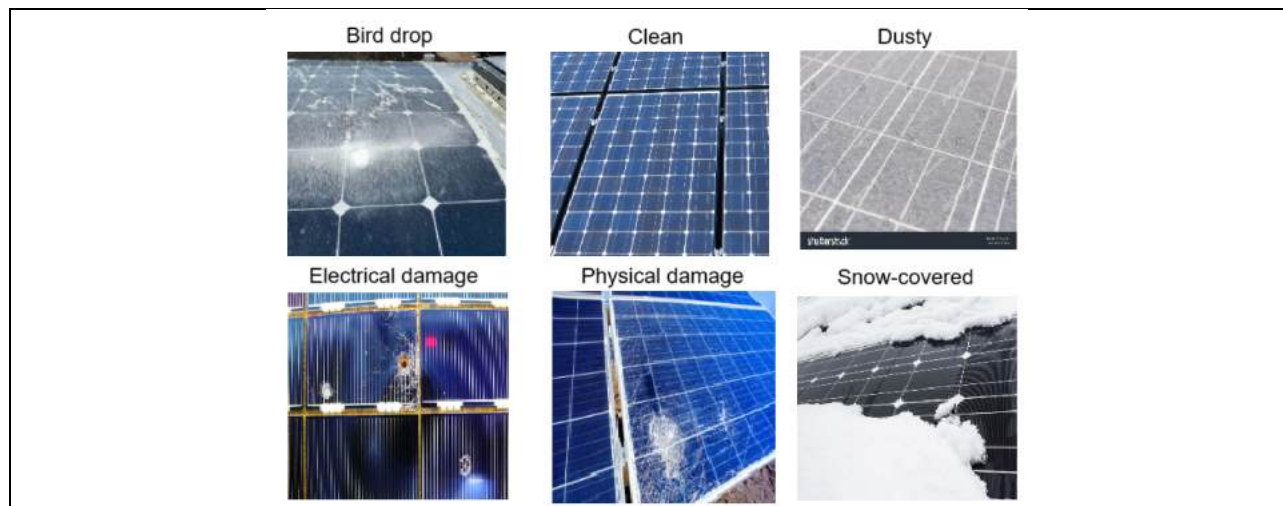


Fig. 1: Sample of images from the dataset with six different classes

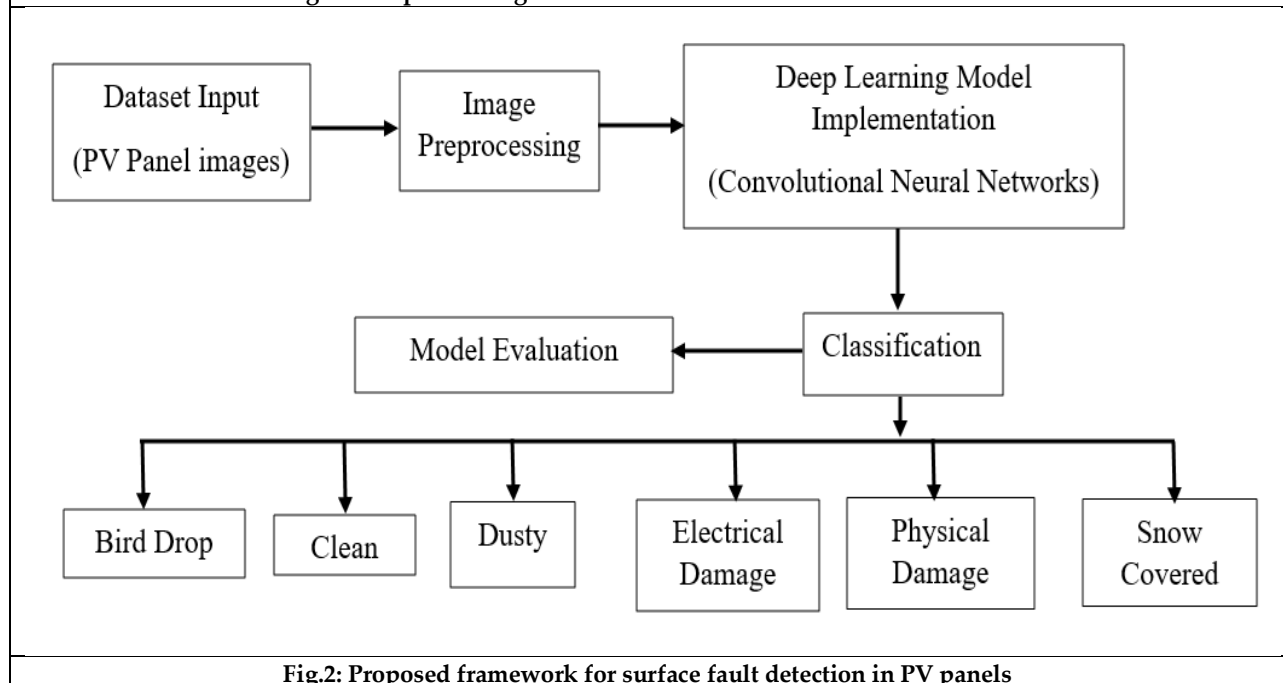


Fig.2: Proposed framework for surface fault detection in PV panels





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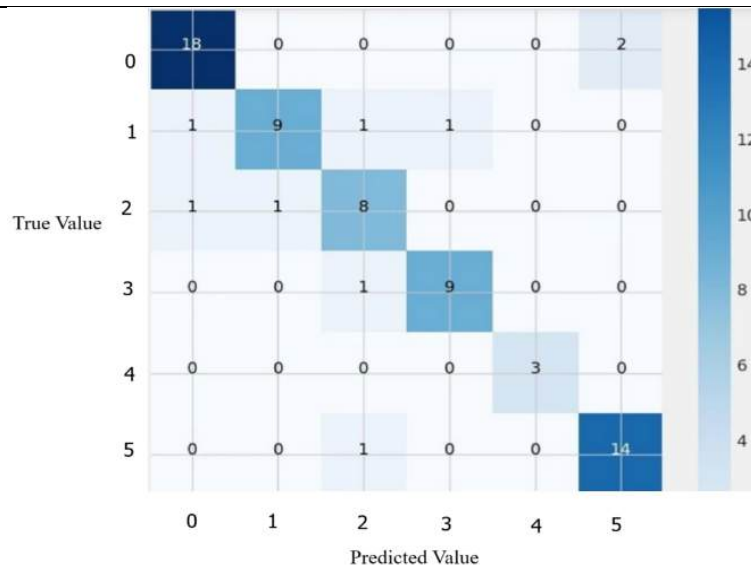


Fig. 3. Confusion matrix of the multi-class classification

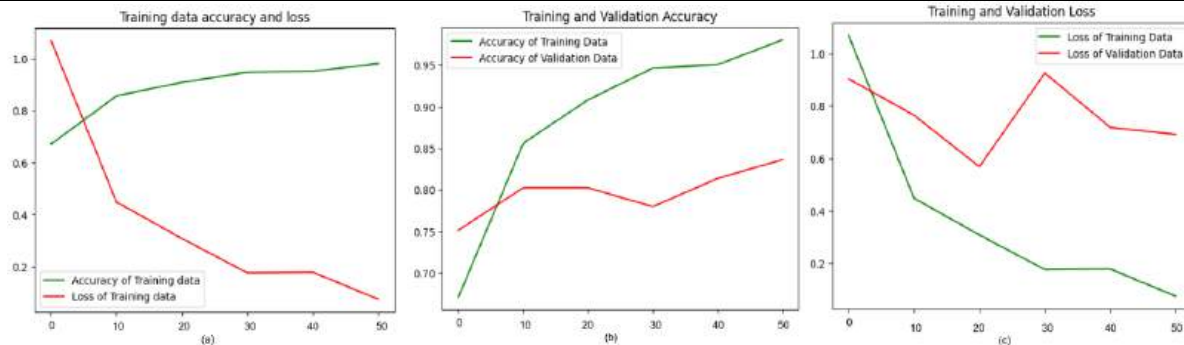


Fig. 4 (a) Loss and accuracy vs. epochs during training, (b) Accuracy vs. epochs during training and validation, (c) Loss vs. epochs during training and validation





Open Access and Academic Libraries: Addressing Challenges and Embracing Opportunities

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ABSTRACT

The emergence of Open Access (OA) has significantly altered the landscape of scholarly publishing by ensuring that research outputs are available online without cost barriers, thereby enhancing the dissemination of knowledge. Academic libraries have been instrumental in advancing the Open Access movement through the establishment of institutional repositories, educating researchers on the advantages of OA, and aiding compliance with funding agency requirements. This article investigates the dynamic interplay between Open Access and academic libraries, highlighting the challenges and opportunities that libraries encounter in their efforts to promote OA initiatives. It delves into critical aspects such as funding, sustainability, policy advocacy, and the influence of OA on scholarly communication. The study concludes with recommendations for strengthening the role of libraries in furthering Open Access and its implications for research accessibility and academic institutions.

Keywords: Open Access (OA), Academic Libraries, Copyright and Licensing, Information Ethics, Institutional Repositories

INTRODUCTION

The Open Access (OA) movement has fundamentally reshaped the conventional academic publishing framework, posing challenges to subscription-based journals and championing the unrestricted availability of scholarly work. OA facilitates open access to peer-reviewed research, allowing a worldwide audience to engage with academic progress. As stewards of knowledge, academic libraries are pivotal in this movement, working to ensure equitable



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access to information while navigating the obstacles present in the current publishing landscape. This article examines the contributions of academic libraries to the Open Access movement and outlines the challenges and opportunities they encounter in supporting OA initiatives.

Opportunities

1. Encourage fair access to academic research by means of Open Access.
2. Use Open Access platforms to expand the reach and influence of research.
3. Talk about licensing and copyright concerns with Open Access publications.
4. Encourage scholars to embrace Open Access policies and guidelines.
5. Create and keep up institutional repositories to ensure accessibility over time.
6. Encourage cooperation to develop long-term Open Access financing and models.
7. Encourage academic institutions to use Open Educational Resources (OER).
8. Promote open access laws at the national and institutional levels.
9. Inform interested parties about the advantages and difficulties of open access.
10. By making Open Access resources available, you may contribute to closing the digital gap.

The Contribution of Academic Libraries to Open Access Initiatives**Institutional Repositories**

Academic libraries have been pivotal in the creation of institutional repositories that serve to archive and provide access to the scholarly outputs produced by their respective institutions. These repositories not only facilitate the dissemination of research findings but also guarantee the long-term preservation of digital materials. By endorsing the establishment of institutional repositories, libraries contribute to diminishing reliance on commercial publishing entities, increasing the visibility of their institution's research endeavors, and ensuring compliance with funding agency requirements that mandate Open Access for published works.

Education and Advocacy

Academic libraries are essential in educating researchers, faculty members, and students regarding the significance and advantages of Open Access. They conduct workshops, webinars, and seminars aimed at informing stakeholders about various Open Access publishing avenues, such as Gold Open Access (publishing in Open Access journals) and Green Open Access (self-archiving in repositories). Furthermore, librarians frequently advocate for policies that support Open Access within their institutions, enhancing awareness of issues related to copyright retention, funding agency mandates, and the overall benefits of the open dissemination of knowledge.

Funding and Sustainability

A significant obstacle that libraries encounter in advancing Open Access (OA) is the issue of funding. OA journals frequently impose article processing charges (APCs) on authors, which can be prohibitively high for researchers, particularly those lacking grant funding. To alleviate these costs, libraries may provide financial support through institutional memberships or dedicated OA publishing funds. Nevertheless, this approach raises concerns regarding sustainability, especially as libraries grapple with tightening budgets. Identifying viable financial models for OA publishing that do not compromise the integrity of scholarly communication remains an essential challenge for academic libraries.

Challenges in Promoting Open Access**Funding Constraints**

With the escalating costs associated with scholarly communication, libraries are increasingly pressured to direct their budgets toward OA initiatives while also addressing other vital areas such as collection development, digital services, and staffing. The enduring viability of OA depends on the creation of models that minimize expenses for both institutions and authors.

Quality Control and Predatory Publishing

Although Open Access seeks to make knowledge more accessible, it has inadvertently led to the emergence of predatory journals that exploit the OA framework for financial gain. These journals often lack thorough peer review processes, resulting in the spread of inferior or unethical research. Libraries have a crucial role in assisting



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researchers in distinguishing between credible OA journals and predatory ones to uphold the integrity of scholarly communication.

Copyright agreements and licensing

Copyright agreements and licensing constraints present significant obstacles for libraries advocating for Open Access (OA). Researchers frequently transfer their copyright to publishers, which restrict their capacity to disseminate their work freely. It is imperative for academic libraries to inform authors about the importance of retaining copyright or utilizing Creative Commons licenses, which facilitate greater autonomy over the distribution of their research findings.

Opportunities for Academic Libraries**Collaboration and Community Building**

Academic libraries possess a distinctive opportunity to engage in collaborative efforts with other institutions, consortia, and funding organizations to strengthen the Open Access framework. Such collaborations can result in shared resources, joint funding initiatives for OA publishing, and enhanced advocacy for policies at local, national, and international levels.

Advancing Scholarly Communication

The Open Access model significantly increases the visibility and influence of academic research by making it available to a broader audience, including individuals in developing nations and non-academic communities. Libraries can utilize OA to promote interdisciplinary research and collaboration, fostering innovative methods of knowledge exchange.

Data Sharing and Open Science

The expanding movement towards Open Science, which encompasses the sharing of research data, methodologies, and software, is in harmony with the principles of Open Access. Academic libraries can assume a pivotal role in advocating for data repositories and offering services that facilitate the open sharing of research data, thereby improving transparency and reproducibility in scientific endeavors.

CONCLUSION

Academic libraries play a pivotal role in the Open Access movement, promoting fair access to scholarly resources and assisting researchers in the intricate landscape of Open Access publishing. Despite ongoing challenges, including financial limitations, predatory publishing practices, and copyright concerns, libraries are actively innovating by creating institutional repositories, encouraging collaborative efforts, and advocating for necessary policy reforms. As the academic publishing environment transforms, it is essential for academic libraries to stay adaptable, responding to new demands while upholding Open Access as a vital means of facilitating global knowledge sharing.

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A Review on Tool Life Comparison between Conventional Machining, CNC Machining and Abrasive Machining Process

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ABSTRACT

Tool life is a critical factor influencing productivity, cost, and quality in manufacturing. Different machining processes, including conventional machining, Computer Numerical Control (CNC) machining, and abrasive machining, exhibit distinct characteristics in terms of tool wear and life expectancy. This paper reviews the factors affecting tool life in these processes, comparing them based on material removal mechanisms, cutting tool materials, wear mechanisms, and operating parameters. The review consolidates insights from multiple studies to offer a comparative analysis that could inform decision-making in selecting appropriate machining methods for specific applications, ultimately contributing to more efficient manufacturing processes.

Keywords: Tool Life, Conventional Machining, CNC Machining, Abrasive Machining, Wear Mechanisms

INTRODUCTION

Machining processes are pivotal in modern manufacturing, serving as fundamental techniques for shaping and finishing materials across a multitude of industries, including aerospace, automotive, and electronics. The ability to accurately and efficiently create parts from raw materials is essential for ensuring product performance and meeting industry standards. As manufacturing technologies evolve, the need for enhanced efficiency and precision has become increasingly critical, making the study of tool life a priority for engineers and manufacturers. Tool life is defined as the duration a cutting tool can operate effectively before it becomes unusable due to wear, damage, or failure [1]. This metric is not merely an operational statistic; it significantly influences production efficiency, cost-effectiveness, and the overall quality of manufactured products. Understanding the factors that affect tool life is essential for optimizing machining operations and improving productivity. Various factors contribute to tool wear, including cutting speed, feed rate, material properties, and tool material [2]. Each machining process—whether



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conventional, CNC, or abrasive—exhibits unique characteristics and challenges regarding tool life. Conventional machining processes, which rely on manual operation, often face variability in tool performance due to operator skill and external conditions. In contrast, CNC machining offers automation and precision, allowing for more consistent tool life by minimizing human error and optimizing cutting conditions [3]. Abrasive machining processes present another layer of complexity. These processes, which utilize hard particles to remove material, often result in different wear mechanisms that can lead to shorter tool life despite their effectiveness in achieving high surface finishes [4]. As industries seek to enhance production efficiency and reduce costs, a comprehensive understanding of tool life across different machining methods becomes increasingly valuable. This review aims to provide a detailed comparison of tool life in conventional, CNC, and abrasive machining processes, exploring the underlying mechanisms of wear and the implications for manufacturing practice. By consolidating insights from various studies, the paper seeks to inform decision-making in selecting appropriate machining methods for specific applications, ultimately contributing to more efficient manufacturing processes.

The primary objective of this research is to systematically analyze and compare the tool life across three distinct machining processes: conventional machining, CNC machining, and abrasive machining. This study aims to identify and investigate the various factors influencing tool life, such as cutting speed, material properties, tool materials, and coolant application. Additionally, it will examine the different wear mechanisms associated with each process, highlighting their implications for tool performance. A comparative analysis will assess the advantages and disadvantages of each method in terms of productivity, cost-effectiveness, and output quality. The research seeks to provide insights and recommendations for manufacturers to aid in selecting appropriate machining methods based on specific application requirements, thereby optimizing operational efficiency and reducing costs. Ultimately, this study aims to establish a foundational understanding of tool life dynamics to guide future research into advanced machining technologies and practices.

Machining Processes Overview**Conventional Machining**

Conventional machining encompasses manual processes such as turning, milling, drilling, and grinding, where skilled operators control the cutting tools. These processes are characterized by their reliance on human judgment and experience, which can significantly affect tool life and performance [3]. Factors such as cutting speed, feed rate, and depth of cut are often adjusted based on operator discretion, leading to variability in operational conditions. The materials being machined also play a crucial role; harder materials can induce accelerated wear on cutting tools. Tool wear in conventional machining primarily occurs due to adhesive and abrasive wear mechanisms, where the tool material interacts with the work piece, leading to material transfer and loss. The requirement for frequent re-grinding and replacement can lead to increased downtime and operational costs. Additionally, the lack of automated feedback systems means that wear may go unnoticed until it affects the quality of the finished product. Despite these challenges, conventional machining is still widely used, especially for simpler operations and smaller production runs, where flexibility and adaptability to varying tasks are essential. Understanding the limitations and operational intricacies of conventional machining is vital for optimizing its efficiency and extending tool life. Factors like vibration, inconsistent feed rates, and unoptimized cutting parameters often lead to increased tool wear and shorter tool life. Moreover, tool life can vary significantly between operators based on experience and technique [4]. Due to inconsistent operating conditions and the frequent need for tool re-grinding, tool life in conventional machining is often shorter than in CNC processes.

CNC Machining

CNC machining automates the machining process using pre-programmed software to control the movement of tools along multiple axes [5]. This automation results in high precision, consistency, and the capability to perform complex geometries that would be difficult or impossible with conventional methods. CNC machines can maintain optimal cutting conditions, which directly contributes to improved tool life compared to conventional machining. CNC (Computer Numerical Control) machining represents a significant advancement over conventional methods by automating the machining process through computer-controlled movements. This technology allows for high





precision and repeatability, making it ideal for complex geometries and high-volume production. CNC machines operate using pre-programmed software that dictates the movement of tools along multiple axes, thereby reducing the variability associated with manual operations. The ability to maintain optimal cutting conditions—such as precise cutting speeds and feed rates—results in improved tool life compared to conventional methods. Moreover, modern CNC machines are often equipped with advanced tool monitoring systems that can assess tool condition in real-time, allowing for adjustments to be made dynamically. This capability minimizes the risk of excessive wear and prolongs tool life. However, the initial investment in CNC machinery can be substantial, and the setup requires skilled personnel to program and operate the machines effectively. The trade-off, however, is that the efficiency gains and consistency in quality often justify the costs. Overall, CNC machining has revolutionized manufacturing by enhancing productivity, reducing waste, and achieving high-quality finishes, making it a preferred choice in many industries. Furthermore, CNC machines can be equipped with advanced tool monitoring systems that dynamically adjust parameters such as feed rate and cutting speed based on real-time data, thus minimizing tool wear [6]. These systems can also predict tool failure, allowing for preemptive tool changes that reduce downtime and maintain productivity. The adaptability of CNC machining to various materials and conditions makes it a favored choice in modern manufacturing [7].

Abrasive Machining

Abrasive machining involves the removal of material using abrasive particles bonded to wheels, belts, or other forms [8]. Common processes include grinding, honing, and lapping, primarily used for finishing operations or hard materials. Abrasive machining is particularly effective for achieving superior surface finishes and high dimensional accuracy, which are essential in industries such as aerospace and automotive. Abrasive machining encompasses processes like grinding, honing, and lapping, which utilize hard particles bonded to a wheel or belt to remove material. This method is particularly advantageous for achieving high precision and superior surface finishes, making it essential in industries where tolerance and surface quality are paramount, such as aerospace and automotive. Abrasive machining is often employed for hard materials, including hardened steels and ceramics, where conventional cutting tools may struggle to maintain performance. The wear mechanisms in abrasive machining differ significantly from those in conventional and CNC processes. The primary wear mode is abrasive wear, where the cutting edges of tools are subjected to constant impact and friction from abrasive particles. This can lead to shorter tool life, requiring careful management of parameters such as feed rate and coolant application to mitigate wear. Additionally, the cost of superabrasive materials, like diamond or cubic boron nitride, while effective, can be prohibitive. Despite the challenges associated with tool life, abrasive machining remains vital for specialized applications, underscoring the need for ongoing research into improving tool materials and wear mechanisms to enhance overall efficiency. However, the abrasive nature subjects tools to different wear mechanisms compared to conventional and CNC machining, often resulting in shorter tool life. The wear in abrasive machining is typically more aggressive due to continuous contact between the abrasive material and the work piece [9]. Nevertheless, advancements in abrasive technologies, such as the development of superabrasives like CBN and diamond, have improved tool life and performance, albeit at a higher cost [10].

Factors Influencing Tool Life

Tool life across different machining processes is influenced by several factors, including cutting speed, material properties, tool material, coolant application, and wear mechanisms.

Cutting Speed and Feed

In both conventional and CNC machining, higher cutting speeds generally lead to faster tool wear due to increased friction and temperature at the cutting edge [11]. The balance between cutting speed and material removal rate is crucial; while higher speeds can enhance productivity, they can also lead to rapid deterioration of the tool. CNC machining allows for precise control of cutting speeds, enabling operators to optimize tool life by adjusting parameters according to material characteristics and desired outcomes. Cutting speed and feed rate are critical parameters that significantly influence tool life in machining processes. The cutting speed, defined as the speed at which the cutting tool engages the work piece, directly affects the temperature generated at the cutting edge. Higher





cutting speeds often lead to increased friction, which can accelerate wear due to thermal effects, including softening of the tool material and the onset of thermal cracking. Conversely, too low a cutting speed may result in ineffective material removal and poor surface finish. Feed rate, the distance the tool advances with each revolution or pass, also plays a vital role. An optimal feed rate enhances productivity by increasing material removal rates; however, excessive feed can increase the load on the tool, leading to premature wear. In CNC machining, precise control of these parameters allows for optimization, balancing productivity and tool longevity. Real-time monitoring systems can further enhance this optimization by adjusting cutting conditions dynamically based on observed wear patterns. Understanding the interplay between cutting speed and feed rate is essential for manufacturers to extend tool life and improve the efficiency of machining operations, ultimately leading to reduced costs and improved product quality. Conversely, abrasive machining processes require much higher surface speeds to effectively remove material, which can exacerbate wear [12]. The interplay between cutting speed, feed rate, and tool life is complex, and optimizing these parameters is essential for maximizing efficiency.

Material Properties

The properties of the material being machined significantly affect tool life. Harder materials generate more wear on the tool, leading to increased frequency of tool replacement. In conventional and CNC machining, tool wear is generally more severe when machining high-strength alloys or materials with abrasive inclusions [13]. The properties of the material being machined have a profound impact on tool life. Factors such as hardness, toughness, and abrasiveness dictate how a material interacts with the cutting tool, influencing wear mechanisms and rates. Harder materials generally cause more significant wear on tools, as the cutting edge must exert more force to shear the material. This increased force can lead to rapid tool degradation, especially in conventional and CNC machining, where tools are directly engaged with the work piece. Additionally, materials with abrasive inclusions or irregular structures can exacerbate wear, further complicating the machining process. In contrast, materials that are ductile may allow for smoother cutting actions, resulting in lower wear rates. The selection of appropriate tool materials is crucial; for example, carbide tools offer enhanced wear resistance when machining high-strength alloys. Furthermore, the use of coatings can also improve tool life by reducing friction and protecting the tool from thermal and chemical wear. Understanding material properties enables manufacturers to select suitable tooling and machining parameters, optimizing tool life while maintaining quality and performance in their production processes. Although abrasive machining is adept at handling these tougher materials, tool wear remains a challenge due to constant engagement with hard surfaces. Material properties such as hardness, toughness, and thermal conductivity must be considered when selecting tools and machining parameters to ensure optimal tool life [14].

Tool Material

The choice of tool material is crucial in determining tool life. High-speed steel (HSS), carbide, and ceramics are commonly used in conventional and CNC machining [15]. Carbide tools generally exhibit superior wear resistance, particularly in CNC operations, due to their ability to maintain optimal cutting conditions and their inherent hardness. The material composition of cutting tools is a pivotal factor influencing tool life and performance. Common tool materials include high-speed steel (HSS), carbide, and ceramic, each possessing distinct properties that determine their suitability for specific applications. For instance, carbide tools, known for their hardness and wear resistance, are often preferred in CNC machining due to their ability to maintain sharp cutting edges under high-speed conditions. This results in longer tool life and reduced frequency of tool changes, enhancing productivity. Conversely, HSS tools, while more affordable and easier to sharpen, may not withstand the high temperatures generated during machining as effectively as carbide. Ceramic tools, although exceptionally hard and capable of high-speed operations, are brittle and can fracture under shock loads. Moreover, advancements in tool coatings—such as titanium nitride (TiN) or diamond-like carbon (DLC)—further enhance tool life by reducing friction and thermal effects. The choice of tool material must be aligned with the specific requirements of the machining process, including the type of material being machined and the operating conditions. Optimizing tool material selection is essential for improving tool life, enhancing operational efficiency, and achieving desired product quality. In abrasive machining, diamond and cubic boron nitride (CBN) abrasives are preferred for their exceptional hardness and wear resistance. However, their high cost and specific wear challenges limit their application in some contexts [16]. The





selection of tool material should align with the specific machining requirements and the properties of the work piece [17].

Wear Mechanisms

Wear mechanisms differ among machining processes. In conventional and CNC machining, common mechanisms include adhesive wear, abrasive wear, and thermal cracking [18]. The thermal effects generated during machining can lead to tool degradation through softening and micro structural changes. Understanding wear mechanisms is crucial for comprehending tool life in various machining processes. Tool wear occurs due to several mechanisms, including adhesive wear, abrasive wear, fatigue wear, and thermal cracking, each influenced by operational parameters and material properties. Adhesive wear occurs when material from the work piece transfers to the tool surface, often exacerbated by high temperatures and pressures during cutting. This can lead to significant material loss and deterioration of cutting edges. Abrasive wear is predominant in processes like grinding and abrasive machining, where hard particles interact with the tool, leading to gradual erosion. In CNC and conventional machining, tool fatigue can result from cyclic loading, causing micro-cracking and eventual failure. Additionally, thermal cracking is a critical concern, particularly at high cutting speeds where excessive heat can weaken the tool structure. Effective management of these wear mechanisms involves optimizing cutting parameters and employing advanced tool materials and coatings that can withstand wear more effectively. By understanding the various wear mechanisms, manufacturers can develop strategies to extend tool life, improve machining efficiency, and enhance the overall quality of manufactured products. In abrasive machining, abrasive wear is the predominant mechanism, where the tool's surface is eroded by the hard abrasive particles [19]. Understanding these wear mechanisms is essential for developing strategies to enhance tool life, such as optimizing cutting parameters and selecting appropriate tool coatings [20].

Tool Life in Conventional, CNC, and Abrasive Machining: A Comparative Analysis

Conventional Machining vs. CNC Machining

Tools used in conventional machining typically have shorter lives due to the manual nature of operations, which can lead to suboptimal conditions [21]. The variability in operator skill and process control can cause significant differences in tool wear rates. In contrast, CNC machining provides a controlled environment that consistently maintains cutting parameters, significantly reducing wear rates and prolonging tool life [22]. When comparing tool life in conventional machining and CNC machining, a significant disparity emerges due to the inherent operational differences between the two methods. Conventional machining relies heavily on manual control, where the skill and experience of the operator greatly influence the outcome. Variability in cutting conditions—such as inconsistent cutting speeds and feed rates—often leads to unpredictable tool wear rates, resulting in shorter tool life. Manual interventions, such as tool changes and adjustments, are subject to human error, contributing to increased downtime and operational inefficiency.

In contrast, CNC machining automates the cutting process, allowing for precise control over all parameters. This automation facilitates the maintenance of optimal cutting conditions throughout the operation, significantly reducing the wear rate on tools. CNC systems can also employ advanced monitoring technologies to track tool wear in real-time, adjusting parameters as necessary to optimize tool life. Consequently, CNC tools tend to have a longer operational life due to reduced wear and consistent cutting performance. Overall, the automation and precision of CNC machining provide substantial advantages in tool longevity and operational efficiency compared to traditional methods. Furthermore, CNC systems can implement feedback loops that monitor tool condition, allowing for timely interventions that enhance tool longevity. This automated control minimizes human error, ensuring that the tool operates within optimal parameters throughout its life cycle [23].

CNC Machining vs. Abrasive Machining

While CNC machining generally offers longer tool life compared to conventional methods, abrasive machining often leads to shorter tool life due to high forces and continuous abrasive contact with the work piece [24]. The abrasive nature of the machining process subjects the tools to constant wear, although the quality of the finish can compensate





for this drawback. CNC machining and abrasive machining serve different purposes and exhibit distinct characteristics regarding tool life. While CNC machining is designed for efficiency and precision, focusing on material removal through shearing, abrasive machining employs hard particles to achieve fine finishes and precise dimensions. The tool life in CNC machining is generally superior due to the controlled cutting conditions that minimize excessive wear. CNC machines are capable of maintaining optimal speeds and feeds tailored to the material being processed, allowing for consistent tool performance over extended periods. Conversely, abrasive machining often results in shorter tool life due to the continuous contact between the tool and the work piece, which subjects the cutting edges to significant wear from the abrasive particles. Although abrasive processes are essential for achieving high surface quality and tolerances, the aggressive nature of material removal often leads to rapid tool degradation. Advanced abrasive materials, such as diamond and cubic boron nitride, can improve wear resistance but at a higher cost. Ultimately, while CNC machining excels in productivity and tool longevity, abrasive machining remains indispensable for specialized applications where surface finish and precision are critical. Despite the shorter tool life, abrasive machining is indispensable for applications requiring exceptional surface quality and dimensional accuracy. The advanced materials used in abrasives, such as CBN and diamond, have been developed to mitigate wear while maintaining high performance [25].

Conventional Machining vs. Abrasive Machining

When comparing conventional machining to abrasive machining, conventional tools generally last longer under similar conditions due to the more controlled material removal process and less aggressive cutting actions [26]. However, abrasive machining excels in applications where extreme hardness or precision is needed, despite the higher wear rates. The comparison between conventional machining and abrasive machining reveals distinct differences in tool life, primarily driven by their operational mechanisms and intended applications. Conventional machining typically involves the removal of material through cutting, relying on sharp edges to shear away material. While this method can be effective for bulk material removal, tool life is often compromised due to the inherent variability in manual operations and the influence of operator skill. Inconsistent cutting conditions and the frequent need for tool re-sharpening lead to increased wear and shorter tool lifespan. On the other hand, abrasive machining employs hard particles to achieve material removal, primarily in finishing operations. While this process can yield superior surface finishes and tight tolerances, it usually results in accelerated tool wear due to constant engagement with the work piece. The nature of abrasive action can lead to higher wear rates compared to conventional cutting methods, necessitating the use of advanced abrasive materials for improved tool life. Despite the shorter tool life, abrasive machining is essential for applications requiring extreme precision and surface quality, highlighting the need to balance wear rates with the specific demands of the manufacturing process. Conventional machining is typically better suited for bulk material removal, while abrasive machining is crucial for finishing operations that require high precision. Each process has its unique strengths, and the choice between them should align with the specific requirements of the application [27,28].

CONCLUSION

1. CNC machining consistently outperforms conventional machining in terms of tool life due to enhanced control and optimization of cutting parameters.
2. While abrasive machining is critical for achieving high precision and surface finish, it generally results in shorter tool life because of the aggressive wear mechanisms involved.
3. The selection of the appropriate machining process should consider the specific requirements of the application, including the trade-offs between tool life, cost, and operational demands.
4. Ongoing advancements in machining technologies and materials, such as super abrasives, will continue to influence tool life and performance across all machining processes.





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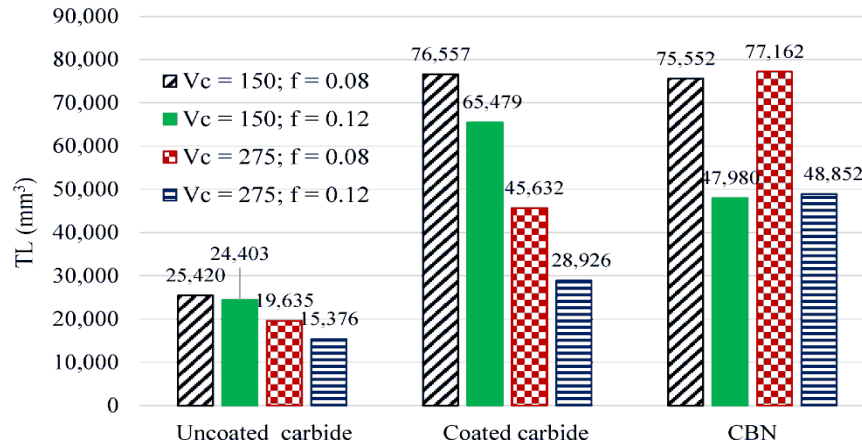


Figure 6: Average tool life (in hours) for conventional, CNC, and abrasive machining

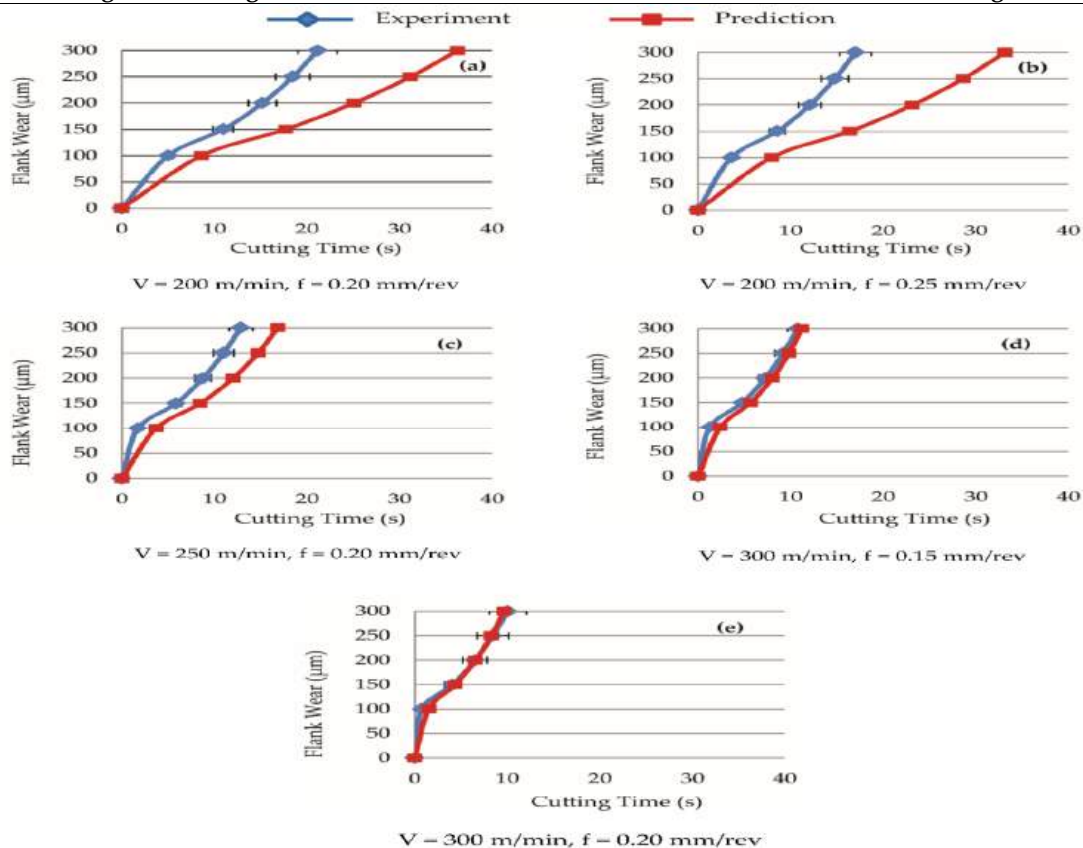


Figure 7: Average tool life for various tool materials for respective machining





A Greener Protocol for the Synthesis of 1,3-Diphenyl-3-(Phenylamino) Propan-1-One Derivatives Using ZnO NPs

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ABSTRACT

Zinc Oxide nanoparticles serve as a highly efficient heterogeneous catalyst for several organic reactions. Many scientists have invested considerable efforts in utilizing nano ZnO as a sustainable catalyst for the synthesis of N- and O-containing heterocyclic compounds. Nano Zinc Oxide was identified as a highly efficient, environmentally friendly, and recyclable heterogeneous catalyst for the synthesis of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives via a one-pot three-component reaction involving substituted aromatic aldehyde, aniline, and aromatic ketone at 80°C, utilizing ethyl alcohol as the solvent

Keywords: 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives, Nano Zinc Oxide, aldehyde, aniline, and aromatic ketone.

INTRODUCTION

In recent decades, multi-component reactions (MCRs) have exhibited considerable effectiveness and efficiency as bond-forming techniques in organic, combinatorial, and medicinal chemistry, especially within the context of green chemistry. Multi-component reactions (MCRs) demonstrate significant flexibility and display atom economy, as they advance through a sequence of reaction equilibria to yield the desired final product. The properties of the catalyst, together with various other reaction parameters, significantly influence the yield, selectivity, and overall



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applicability of a chemical process [1-7]. The quest for a cost-efficient, mild, reusable, and adaptable catalyst for multi-component reactions (MCRs) is a topic of significant interest. Catalysis has been essential in reducing pollution caused by chemical processes in our environment. The use of catalysts in organic reactions improves efficiency and selectivity, resulting in decreased amounts of by-products and waste chemicals. The Mannich reaction is an important method for synthesizing various chemical compounds. Mannich products are commonly utilized in the synthesis of peptides, lactams, amino alcohols, and as precursors for amino acid synthesis. In this regard, we have effectively synthesized β -amino carbonyl compounds by a three-component one-pot synthesis referred to as the Mannich reaction. This synthesis utilized nano ZnO as a very effective and recyclable heterogeneous catalyst. Conventional catalysts utilized in the classical Mannich reaction, which encompasses the reactivity of aldehydes, amines, and ketones, predominantly comprise mineral acids and organic acids. The identification of new MCRs is a compelling subject for researchers in synthetic chemistry. Consequently, as part of our ongoing efforts to devise an eco-friendly method for the synthesis of heterocyclic compounds, we have endeavored to synthesize derivatives of 1,3-diphenyl-3-(phenylamino)propan-1-one utilizing ZnO nanoparticles (Figure 1).

Experimental Methods

Materials and Reagents

All chemicals utilized in this procedure are of analytical reagent quality, requiring no additional purification. The synthesized compounds were analyzed using $^1\text{H-NMR}$ (400 MHz) spectra acquired from a Bruker-Advance spectrophotometer in CDCl_3 . FTIR spectra were obtained using a Bruker Alpha FT-IR with Opus version 6.1, while mass spectra were acquired on a Perkin-Elmer PESCIEX-API 2000, equipped with an ESI source utilized online with an HPLC system following the UV detector. XRD spectra were obtained using a PAN analytical-Xpertpro diffractometer, and the average crystallite size was calculated from the associated XRD data. The microstructural morphology was examined using a JEOL-JSM 6610 LV scanning electron microscope (SEM). Magnetization measurements were conducted with a commercial vibrating sample magnetometer (VSM) model BHU-50 from Riken Denshi Co. Ltd., Japan.

General procedure for the Synthesis of Catalyst:

A 0.2 M solution of $\text{Zn}(\text{NO}_3)_2$ and a 0.4 M solution of NaOH were utilized to prepare the Nano Zinc Oxide catalyst by the wet chemical approach. Zinc nitrate was dissolved in water, and sodium hydroxide was added gradually with constant stirring at room temperature, resulting in the formation of metal hydroxides. The agitation persisted for six hours at 85°C . The reaction mixture was subsequently filtered and dried in an oven at 60°C . The synthesized powder was calcined in a muffle furnace at 600°C for 2 hours and then allowed to cool in the furnace. The product was characterized using SEM, EDAX, and XRD[9-11].

Characterizations of catalyst:

The characterization of nano ZnO was conducted according to JCPDS values. In both doped and undoped ZnO samples, the absorption peaks between 600 and 700 cm^{-1} can be ascribed to the stretching modes of ZnO [10-13]. The FT-IR spectra exhibited principal peaks: absorption peaks between $1100 - 1600\text{ cm}^{-1}$ attributed to the Zn-OH bending mode, which is typically diminished through calcination at elevated temperatures, and a broad band in the $2900 - 3700\text{ cm}^{-1}$ region, interpreted as overlapping O-H and C-H stretching modes (Figure 2). The X-ray diffraction pattern of ZnO nanoparticles exhibits crisp and well-defined peaks. It signifies the superior crystallinity of the produced material. The measured 2θ values align with the standard JCPDS values (JCPDS No. 80-0075), indicating the wurtzite structure of ZnO nanoparticles. The d-values were compared with standard JCPDS files, confirming the presence of pure oxides (Figure 3). The SEM image illustrates the surface morphology of the oxide nanoparticles. Zinc oxide nanoparticles are spherical in form, with an average grain size of less than 70 nm (Figure 4). EDAX verifies the existence of zinc and oxygen in the anticipated atomic percentages (Figure 5) [11-13].



Satheesh *et al.*,**General procedure for the synthesis of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives**

A solution comprising 10 mmol of an aromatic aldehyde, 10 mmol of aniline, and 10 mmol of an aromatic ketone in 10 ml of ethanol was formulated. To this solution, 500 mg of nano ZnO, pre-activated in a microwave oven for 2 minutes, was incorporated. The resultant mixture was thereafter exposed to reflux at 80°C for a period of 3 hours. The reaction's progress was evaluated by thin-layer chromatography, utilizing a solvent mixture of n-hexane and ethyl acetate in a 3:1 ratio. The results collected are displayed in Table 1. Upon completion of the reaction, the catalyst was isolated and then dried in anticipation of its future application [15]. The results indicate that the catalyst maintains consistent activity after five uses, exhibiting no noticeable decrease in performance. The reaction mixture was filtered, yielding the corresponding pure compound via recrystallization with ethanol. The pure compounds underwent investigation via FT-IR, ¹H-NMR, and mass spectrometry to ascertain their properties.

Plausible mechanism for the formation of 1, 3-diphenyl-3-(phenylamino)propan-1-one derivatives.

The viable reaction mechanism of this one-pot three-component reaction can be clarified by consulting prior studies documented in the literature. The reaction mechanism is illustrated in Scheme 2. The first step entails the synthesis of imine 6, generated by the interaction of an aromatic aldehyde with an amine in the presence of a catalyst. The ensuing reaction entails the catalytic formation of enol 7 from acetophenone. The intermediate imine 6 was generated in the initial reaction, followed by the reaction of the in situ formed enol 7, yielding the corresponding derivatives 4, particularly 1,3-diphenyl-3-(phenylamino)propan-1-one[14,15].

Spectral data for the synthesized 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives**1,3-diphenyl-3-(phenylamino)propan-1-one(4a)**

IR (KBr): 3444, 3315 (2°-amine, NH-Str), 1664, 1606 cm⁻¹ (Carbonyl, C=O Str) 1541,1450 (C=C, aromatic Str), ¹H NMR (400 mHz, CDCl₃): δ 4.01-4.04 (m, 1H, NH), 4.98-5.04 (m, 2H, CH₂), 6.68-6.80 (m, 2H, Ar-H), 7.04-7.14 (m, 4H, Ar-H), 7.21-7.30 (m, 2H, Ar-H), 7.37-7.54 (m, 3H, Ar-H), 7.87-7.91 (m, 2H, Ar-H), ESI-MS m/z(%): 302 ([M+H]⁺ 100).

3-(4-Chlorophenyl)-1-phenyl-3-(phenylamino)propan-1-one(4b)

IR (KBr): 3433, 3308(2°-amine, NH Str), 1664, 1606 (Carbonyl, C=O Str), 1528, 1440 (C=C, aromatic Str), 724, 704 cm⁻¹ (-Cl Str). ¹H NMR (400 MHz, CDCl₃): δ 3.54 (m, 1H, CH₂), 3.57 (m, 1H, CH₂), 4.04 (m, 1H, NH), 6.62-6.80 (m, 2H, Ar-H), 7.09-7.30 (m, 2H, Ar-H), 7.38-7.48 (m, 2H, Ar-H), 7.54-7.61 (m, 2H, Ar-H), 7.86-7.90 (m, 2H, Ar-H), ESI-MS m/z(%): 336 ([M+H]⁺ 100).

1-phenyl-3-(phenylamino)-3-(P-tolyl)propan-1-one(4c)

IR(KBr): 3389, 3317(2°-amine,NHStr), 1668,1603(Carbonyl,C=O Str), 1512, 1498(C=C,aromatic Str), 286cm⁻¹(CH₃). ¹H NMR (400 mHz, CDCl₃): δ 2.32(s,3H,-CH₃),4.07 (m,1H,NH), 6.63-6.72(m,2H, Ar-H), 6.88-6.92(m,2H,Ar-H), 7.07-7.15(m,2H,Ar-H), 7.27-7.48(m,4H,Ar-H), 7.86-7.91(m,2H,Ar-H), ESI-MS m/z(%):316 ([M+H]⁺ 100).

3-(2-Chlorophenyl)-1-phenyl-3-(phenylamino)propan-1-one(4d)

IR(KBr) : 3394, 3314(2°-amine,NH Str), 1669,1602(Carbonyl,C=O Str), 1590,1566(C=C,aromatic Str), 775 ,686cm⁻¹(-Cl Str). ¹H NMR (400 mHz, CDCl₃): δ 3.14(m, 1H,CH₂), 3.19(m, 1H,CH₂),4.01 (m,1H,NH),4.49(m,1H,CH) 6.58-6.73(m,2H, Ar-H), 7.06-7.25(m,2H,Ar-H), 7.30-7.34(m,2H,Ar-H), 7.40-7.56(m,2H,Ar-H), 7.86-7.89(m,2H,Ar-H), ESI-MS m/z(%):336 ([M+H]⁺ 100).

1,3-diphenyl-3-(p-tolylamino)propan-1-one(4e)

IR(KBr) : 3389, 3323(2°-amine,NH Str),1673,1666(Carbonyl,C=O Str), 1511,1493, (C=C,aromatic Str),283cm⁻¹(-CH₃ Str). ¹H NMR (400 mHz, CDCl₃): δ 2.32(s,3H,-CH₃),4.07 (m,1H,NH), 6.63-6.72(m,2H, Ar-H), 6.88-6.92(m,2H,Ar-H), 7.07-7.28(m,2H,Ar-H), 7.32-7.44(m,4H,Ar-H), 7.48-7.91(m,2H,Ar-H). ESI-MS m/z(%):316 ([M+H]⁺ 100).

3-((4-chlorophenyl)amino)-1,3-diphenylpropane-1-one(4f)

IR(KBr) : 3616(2°-amine,NH Str), 1615(Carbonyl,C=O Str), 1541,1466(C=C,aromatic Str), 780,727cm⁻¹(-Cl Str). ¹H NMR (400 mHz, CDCl₃): δ 3.18(m, 1H,CH₂), 3.22(m, 1H,CH₂),4.03 (m,1H,NH),4.35-4.45(m,1H,CH), 6.58-6.73(m,2H, Ar-H), 7.05-7.13(m,2H,Ar-H), 7.18-7.28(m,2H,Ar-H), 7.31-7.45(m,2H,Ar-H), 7.87-7.94(m,2H,Ar-H). ESI-MS m/z(%):336 ([M+H]⁺ 100).





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3-(4-hydroxyphenyl)-1-phenyl-3-(phenylamino)propan-1-one(4g)

IR(KBr): 3375(2° -amine, NH Str), 3171(-OH Str), 1615(Carbonyl, C=O Str), 1470, 1412 cm⁻¹ (C=C, aromatic Str). ¹H NMR (400 MHz, CDCl₃): δ 3.15-3.22(m, 2H, CH₂), 4.06 (m, 1H, NH), 4.41-4.48(m, 1H, CH), 5.32(m, 1H, -OH), 6.71-6.81(m, 2H, Ar-H), 7.02-7.15(m, 2H, Ar-H), 7.25-7.41(m, 2H, Ar-H), 7.44-7.50(m, 2H, Ar-H), 7.54-7.93(m, 2H, Ar-H). ESI-MS m/z(%): 318 ([M+H]⁺ 100).

3-((4-bromophenyl)amino)-1,3-diphenylpropan-1-one(4h)

IR(KBr): 3443(2° -amine, NH Str), 1659, 1603(Carbonyl, C=O Str), 1538, 1488(C=C, aromatic Str), 589(-Br Str). ¹H NMR (400 MHz, CDCl₃): δ 3.13(m, 1H, CH₂), 3.18(m, 1H, CH₂), 4.07 (m, 1H, NH), 4.45-4.49(m, 1H, CH), 6.58-6.63(m, 2H, Ar-H), 7.18-7.28(m, 2H, Ar-H), 7.31-7.57(m, 4H, Ar-H), 7.85-7.89(m, 2H, Ar-H). ESI-MS m/z(%): 381 ([M+H]⁺ 100).

3-(4-methoxyphenyl)-1-phenyl-3-(phenylamino)propan-1-one(4i)

IR(KBr): 3377(2° -amine, NH Str), 1664, 1602(Carbonyl, C=O Str), 1510, 1510, 1445(C=C, aromatic Str), 1067, 1027(OCH₃ Str). ¹H NMR (400 MHz, CDCl₃): δ 3.13-3.18(m, 2H, CH₂), 3.86(s, 3H, -OCH₃), 4.07 (m, 1H, NH), 4.48-4.51(m, 1H, CH), 6.63-6.73(m, 2H, Ar-H), 6.88-6.92(m, 2H, Ar-H), 7.07-7.15(m, 1H, Ar-H), 7.27-7.32(m, 1H, Ar-H), 7.44-7.48(m, 2H, Ar-H), 7.86-7.91(m, 2H, Ar-H). ESI-MS m/z(%): 332 ([M+H]⁺ 100).

3-(4-bromophenyl)-1-phenyl-3-(phenylamino)propan-1-one (4j)

IR(KBr): 3313(2° -amine, NH Str), 1658, 1608(Carbonyl, C=O Str), 1487, 1446(C=C, aromatic Str), 588(-Br Str). ¹H NMR (400 MHz, CDCl₃): δ 3.13(m, 1H, CH₂), 3.18(m, 1H, CH₂), 4.06 (m, 1H, NH), 4.41-4.45(m, 1H, CH), 6.58-6.73(m, 2H, Ar-H), 7.18-7.28(m, 2H, Ar-H), 7.31-7.45(m, 4H, Ar-H), 7.87-7.94(m, 2H, Ar-H). ESI-MS m/z(%): 381 ([M+H]⁺ 100).

RESULTS AND DISCUSSION

The present reaction was observed with different amounts of catalyst. The results demonstrate that a catalyst dosage of 500mg is adequate to achieve a favorable product yield. Augmenting the quantity of catalyst beyond a specific threshold does not generate a substantial increase in product output. Consequently, 500 mg of catalyst was employed to facilitate the process. This experiment involved the model reaction (Scheme 1) with a mixture of benzaldehyde, aniline, and acetophenone in ethanol. The results are displayed in Table 2.

Effect of solvent on synthesis of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives:

The analysis of the reaction medium in the studies revealed that solvents substantially impacted the reaction. The results are concisely displayed in Table 3. The findings demonstrated that polar solvents, including CH₃COOH, CH₃CN, and C₂H₅OH, displayed markedly enhanced efficacy relative to non-polar solvents. A negligible yield was observed when water was utilized as the solvent, possibly due to the aggregation of the hydrophobic catalyst. Notwithstanding the efficacy of CH₃COOH, the reapplication of the catalyst yielded a suboptimal output. Thus, ethanol was selected as the solvent.

Effect of Temperature on synthesis of 1, 3-diphenyl-3-(phenylamino)propan-1-one derivatives.

Table 5 displays the reaction temperature of 80 °C for the production of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives utilizing the MTSA catalyst. The experimental results demonstrated that at temperatures below 80 °C, the reaction yield was relatively low, while the reaction period was considerably prolonged. The experiment was performed at a temperature of 80 °C.

Recycling of the Catalyst

The reusability of catalysts is a significant aspect of heterogeneous catalysis. Catalyst recycling was accomplished by filtering the reaction mixture, washing the catalyst three times with ethyl acetate, drying it, and then introducing fresh reactants dissolved in ethyl alcohol into the round-bottom flask, followed by refluxing to facilitate the subsequent reaction. The catalyst was reused five times consecutively without any significant loss of catalytic activity (Table-5).



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CONCLUSION

The use of ZnO NPs as a catalyst in the Mannich process, which includes aldehydes, amines, and ketones, has shown remarkable results. This catalyst offers a variety of advantages. The initial steps involved in preparing the catalyst are quite simple. Furthermore, the catalyst necessitates a minimal loading and facilitates straightforward operation. Furthermore, it enables a high yield while eliminating the generation of any by-products. Moreover, the catalyst exhibits excellent recyclability and can be reused, which significantly boosts its practicality. This study primarily contributes to the effective synthesis of ZnO NPs, showcasing a balanced relationship between recyclization and activity within the framework of the Mannich reaction.

Declarations

Competing interests: There are no competing interests

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Table 1. Synthesis of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives.

S.No.	Compound	R ₁	R ₂	Time (Hrs)	Yield (%)
1	1,3-diphenyl-3-(phenylamino)propan-1-one(4a)	H	H	3	96
2	3-(4-Chlorophenyl)-1-phenyl-3-(phenylamino)propan-1-one(4b)	4-Cl	H	3.25	95
3	1-phenyl-3-(phenylamino)-3-(p-tolyl)propan-1-one(4c)	4-CH ₃	H	3	96
4	3-(2-Chlorophenyl)-1-phenyl-3-(phenylamino)propan-1-one(4d)	2-Cl	H	3.25	95
5	1,3-diphenyl-3-(p-tolylamino)propan-1-one.(4e)	H	4-CH ₃	3.25	95
6	3-((4-chlorophenyl)amino)-1,3-diphenylpropane-1-one(4f)	H	4-Cl	3.5	94
7	3-(4-hydroxyphenyl)-1-phenyl-3-(phenylamino)propan-1-one(4g)	4-OH	H	4	94
8	3-((4-bromophenyl)amino)-1,3-diphenylpropan-1-one(4h)	H	4-Br	3.5	95
9	3-(4-methoxyphenyl)-1-phenyl-3-(phenylamino)propan-1-one(4i)	4-OCH ₃	H	4	94
10	3-(4-bromophenyl)-1-phenyl-3-(phenylamino)propan-1-one (4j)	4-Br	H	3.5	95

Table 2: Effect of catalyst loading on forming 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives.

S. No.	Catalyst loading in (mg)	Time (Hrs)	Yield (%)
1.	200	3	42
2.	300	3	66
3.	400	3	78
4.	500	3	96
5.	600	3	96

Table 3. Effect of solvent on synthesis of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives

S.No	Catalyst	Solvent	Time(hrs)	Yield(%)
1	MTSA	H ₂ O	48	Trace
2	MTSA	CH ₂ Cl ₂	20	30
3	MTSA	CH ₃ COOH	12	85
4	MTSA	CH ₃ CN	5	90
5	MTSA	C ₂ H ₅ OH	3	96



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Table 5. Effect of Temperature on the formation of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives

S. No.	Catalyst	Temp (°C)	Time (hrs)	Yield (%)
1	MTSA	R.T.	30	20
2	MTSA	40	20	50
3	MTSA	50	12	75
4	MTSA	70	3	96

Table 6. Recyclability of the catalyst in the reaction, synthesis of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives

Run no.	Yield (%)
1	96
2	95
3	94
4	91
5	90

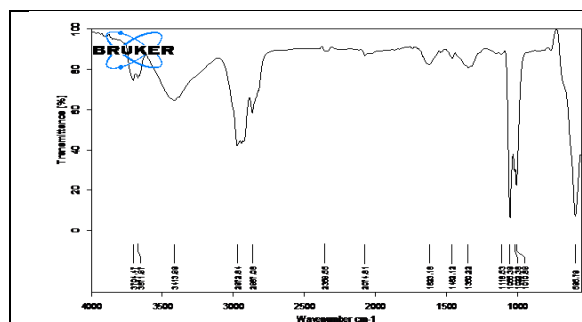


Figure 2 (FT-IR of nano ZnO)

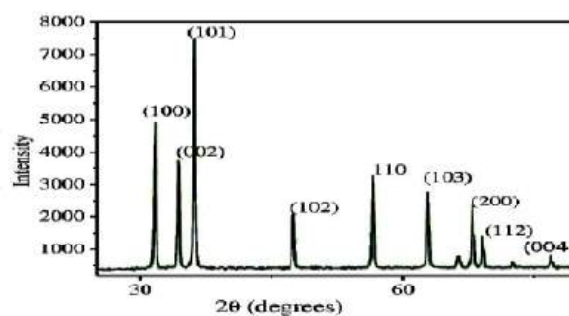


Figure 3 (XRD of nano ZnO)

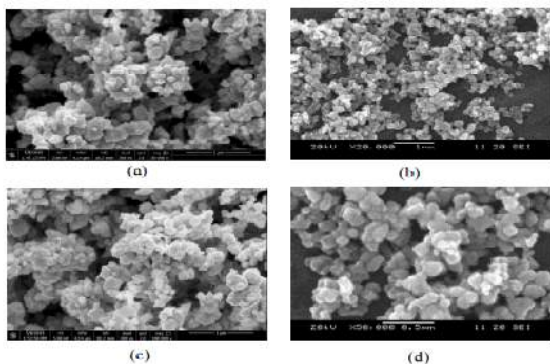


Figure 4 (SEM of nano ZnO)

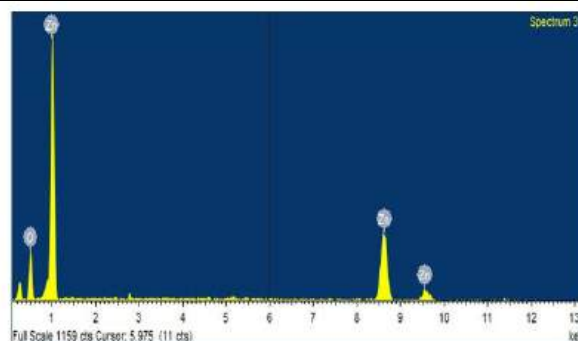
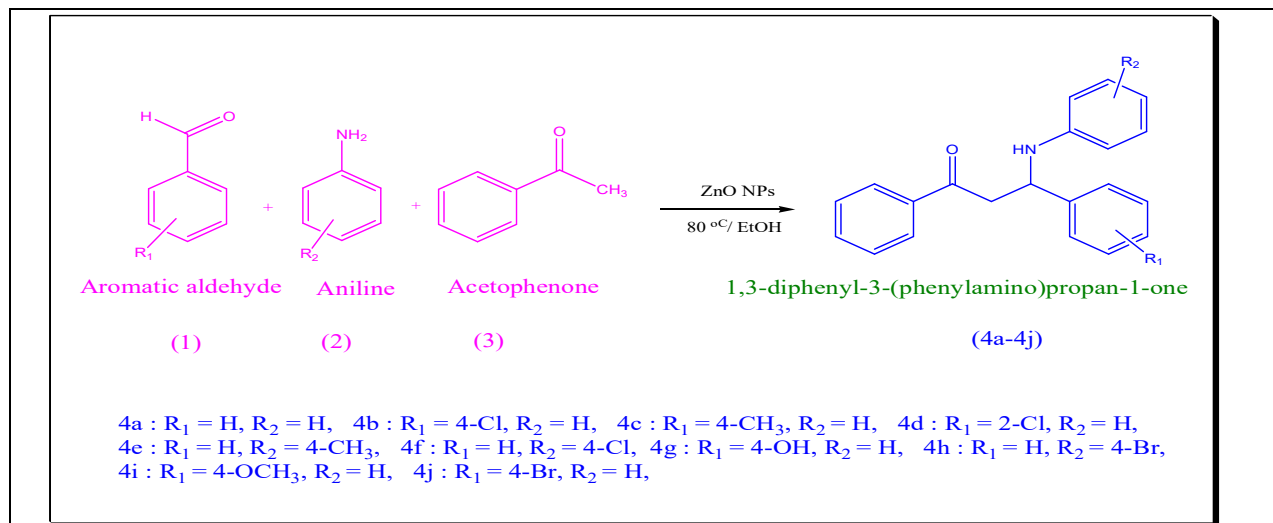


Figure 5 (EDAX of nano ZnO)

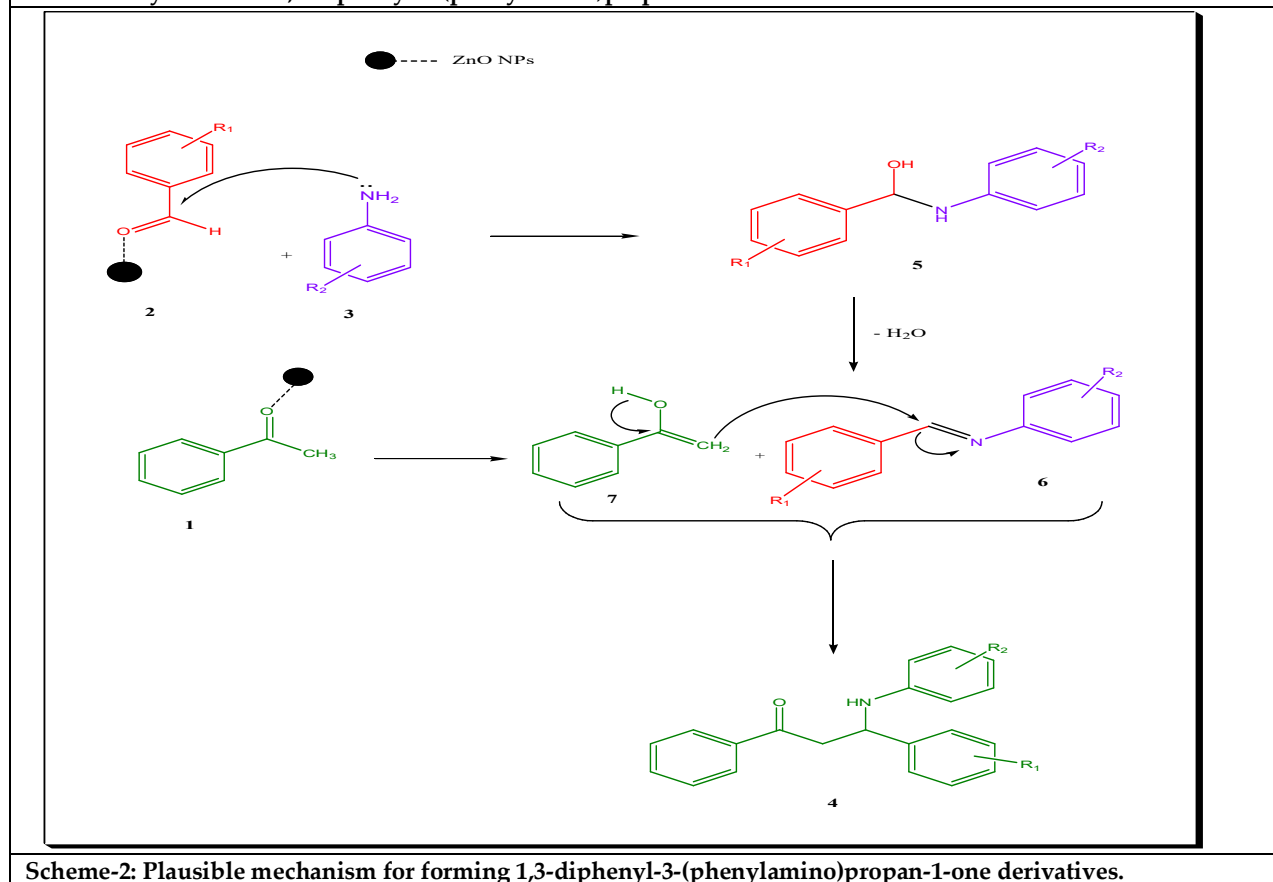




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Scheme 1: Synthesis of 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives



Scheme-2: Plausible mechanism for forming 1,3-diphenyl-3-(phenylamino)propan-1-one derivatives.





Ti-Co, Zr-Co Non-Evaporable Getter Materials

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ABSTRACT

This present work aims at investigating the effects of a series of Titanium-Cobalt and Zirconium-Cobalt getter materials are synthesised varying their contents ratios and characterizing with XRD, TG/DSC and SEM with EDS techniques. The X-ray diffraction, studies confirmed both are the formation of cubic (body centered cubic) spinel structures. The thermo-gravimetric analysis revealed the presence of materials' endothermic and exothermic behaviour that depends on the temperature. The four different mechanisms of sorption processes are discussed besides observed activation of the materials. In this analysis normally used a nitrogen environment. The purpose of this work is better understanding nitrogen absorption properties. Obtained SEM photographs expose the variations of morphological structures and average grain size distributions lying between 15 μ m-18 μ m. In this, Ti-Co and Zr-Co getters were prepared by conventional metallurgical process at the higher activation temperature and longer activation time improving the better sorption properties than Ti, Zr getters.

Keywords: Titanium-Zirconium-Cobalt Getters materials, sorption, adsorption, thermal analysis, grain size:

INTRODUCTION

Non-evaporable getter (NEG) materials have variety of applications in the emerging innovative modern technologies of vacuum systems. These materials possess potential applications for storage of Isotopes and hydrogen, particle accelerators, evacuated solar collectors, plasma fusion machines [1-4]. NEG materials mainly consist of IVth group



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metals such as Ti, Zr, V, Fe etc. During recent periods titanium and zirconium based NEG materials found to use widely for maintaining good vacuum levels in the evacuated packing(s). Vacuum sealed enclosures enhance the gas-absorption properties yielding high bonding stability with lowest expenses of manufacturing [4-5]. The NEG's are used to absorb residual active gases such as H₂, CO₂, CO, N₂, O₂, H₂O etc in the ultra high vacuum systems and sealed devices [6-10]. For the development of non-evaporable getter materials, appropriate concentration of suitable reactive materials like Ti, Zr, V along with one of the structural metals like Fe, Al, Co is required [11-13]. The synthesis of titanium and zirconium based getter materials that have good chemical structure; bonding interstitial sites, mechanical strength at room temperature as well as at evacuated temperature up to 1000 °C can be done. Analysis of the prepared NEG materials' absorption properties of residual gases is essential [14-15] to understand their suitability for applying them as enclosures of vacuum sealing.

Earlier investigators [4, 7, 13, 16] observed Ti-Co, Zr-Co based compounds as more appropriate and suitable getter materials in some aspects relative to others. Though so far different experimental techniques were used to study the characterization of these materials; however techniques pertaining to thermal analysis namely TGA/DTA and DSC seem to be not used for characterization of these materials and almost no information is available in the literature[21]. Thus, by using these techniques; Non-evaporable getter (NEG) materials need to be investigated for more understanding of these materials. The aim of the present work is to characterize Non-evaporable getter (NEG) materials by using the thermal analysis techniques such as TGA/DTA and DSC in order to understand the residual gas absorption properties along with the structural morphological studies by using X-ray powder diffraction(XRD), scanning electron microscopy(SEM), energy dispersive spectroscopy(EDS) morphological investigations,

Synthesis of NEG Materials and Experimental Details

The present Non-evaporable getter (NEG) materials are prepared by following established ceramic route starting with Ti (Sigma Aldrich with purity 99.9%), Zr (Sigma Aldrich with purity 99.9%) and Co (Sigma Aldrich with purity 99.9%) metal powders as raw elements observing the stoichiometric ratios of the chemical compositions of Ti_{640+x}+Co_{360-x} and Zr_{640+x}+Co_{360-x} where x varies in steps of 040 between x = 000 to 160. Initially the raw materials were thoroughly grinded for 12 hours by using mortar and pestle; further mixed with absolute ethanol to obtain homogeneity of the materials. Then materials were annealed in air for 2 hours at 1000°C in a muffle furnace to form compounds. After cooling down to room temperature, the obtained materials were crushed in the mortar for 4 hours to get them in powder form and a binder namely polyvinyl alcohol (PVA) added; further mixed thoroughly. Then these materials were pressed with a pressure of 3 tons for 5 minutes to obtain pellets in the form of circular discs. The synthesised present materials were characterised with different experimental techniques. The Panalytical X-pert pro diffractometer containing diffraction angle in the range 10° to 80° with 0.02° increments is used to collect the XRD pattern of the both materials. Thermal analysis was performed to understand exothermic and endothermic behaviour of the materials with the measurements carried out by TG/DTA/DSC techniques. The make and model of the technique is Mettler Toledo TG/DTG 851^e apparatus possessing the range 30 °C - 1000°C in N₂ gas atmosphere at 10 °C/min rate of heating with constant pressure. Morphological investigations and elemental distribution of the synthesized materials were carried out by using scanning electron microscope and EDS make model JEOL JSM-6610LV. The below table (1) shows that the composition, activation temperature and activation time of Ti-Co and Zr-Co based getter materials.

RESULTS AND DISCUSSION

Structural information of the both series of Ti-Co and Zr-co getter materials has been collected to based on the obtained spectra's of XRD measurements. Similarly micro structural details have been provided by the photographs traced by the SEM. Further to study the nitrogen sorption property of these materials impact of the temperature to analyse thermal reactions of the materials has also been received as it required for assessing the thermal behaviour of these materials during application of them at different temperatures. These results are given below along with their interpretation.





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XRD Studies

The series-1 obtained X-ray diffraction pattern of the synthesized Ti-Co series getter materials is depicted in Fig. 1. It observed to contain major fingerprint peaks (1 0 0), (1 1 0), (1 1 1), (2 0 0), (2 1 0) and (2 1 1) that indexed as hkl values or Miller indices are legibly identifiable with JCPDS Card # 03-065-5351. It interesting to note the three strong peaks found around $2\theta = 29.88^\circ$, 35.98° and 54.10° are corroborated with the earlier investigations [6, 10, 19-22]. With the decrease of Co content in the chemical composition, the major diffraction peaks are shifted to lower angle side. The values of their corresponding Bragg angles and the lattice parameter (a) are computed by using Unit Cell software. By using the Debye-Scherrer's formula [10, 23-25], the crystallite sizes of the present Ti-Co getter materials are evaluated based on FWHM of the most intense diffraction peak (1 0 0). All these values are listed in table 2.

The present materials found to show cubic phases of bcc form that have the same structure as β -titanium with the space group of Pm-3m. The lattice constant as well as lattice volume and crystallite sizes decreases with the decrease of Co concentration while Ti concentration correspondingly increases. The obtained average values of crystallite size are in the range 3.43 nm and 2.62 nm as shown indicated in table1. The decrease of crystallite size; particularly for lower concentration of cobalt facilitates to increase the surface area of the materials. Contrary to this; lattice parameter (a) and unit cell volume found to increase with the decreased content of cobalt. Significantly starting composition of the alloy that has lower Ti and higher Co contents too found to show higher values of all the parameters such as crystallite size; lattice parameter (a) and unit cell volume. These may be understood on the basis of crystalline nature of cobalt and titanium elements. Observed other small diffraction peaks indicate the existence of Ti and Co contents in the XRD pattern in Fig 1. With extended activation time, nano-crystalline nature diminishes with the decrease of Co content or increase of Ti in the chemical composition. The observed little bit amorphous regions of crystallite in Fig 1 decreases FWHM of the diffraction peaks. This is corroborated with the thermal analysis studies.

The second obtained X-ray diffraction pattern of the synthesized Zr-Co series getter materials is depicted in Fig. 2. It observed to contain major fingerprint peaks (1 0 0), (1 1 0), (1 1 1), (2 0 0), (2 1 0) and (2 1 1) that indexed as hkl values or Miller indices are legibly identifiable with JCPDS Card # 00-018-0436. It interesting to note the four strong peaks found around $2\theta = 27.41^\circ$, 36.01° , 53.54° and 63.16° are corroborated with the earlier investigations With the decrease of Co content in the chemical composition, the major diffraction peaks are shifted to lower angle side. The values of their corresponding Bragg angles and the lattice parameter (a) are computed by using Unit Cell software. By using the Debye-Scherrer's formula [10, 23-25], the crystallite sizes of the present Zr-Co getter materials is about 4nm to 2nm because of the zirconium intensity is decreases this can be evaluated based on FWHM of the most intense diffraction peak (2 0 0). All these values are listed in table 3.

Thermal Analysis

The obtained spectra's of TG/DSC for different ratios of Ti-Co and Zr-Co powder materials those heated at $10^\circ\text{C}/\text{min}$ in flowing nitrogen atmosphere with constant supply of pressure are shown in the figures below 3(a) & (b). The First observed TG curve of Ti-co getter materials from the temperature 195°C to 235°C shows a small weight gain of the material because of the adsorption of nitrogen atoms on the sample surface. After that there is no adsorption taking place between the temperature from 240°C to 500°C . The large rate of weight increase of the Ti-Co getter material from the temperature is 550°C to 950°C is due to higher surface area, and also due to it's change in the adsorption system to a reaction system. The reaction system of the nitrogen adsorption on the Ti-Co getter material contains many complex systems such as adsorption or desorption on the materials surface reaction rate between nitrogen and the material surface solubility and diffusion rate of nitrogen atoms in the samples. Similarly the second observed TG curve of Zr+Co getter materials from the room temperature to 400°C shows that there is no weight gain and no reaction takes place because the sample does not adsorbs the nitrogen atoms. After this it is noted that, from the temperature range 400°C to 950°C the weight of the sample gradually increases because of the strong nitrogen-absorption capability of this material [16].





The formation of getter materials can be estimated through DSC measurements. The low pre-sintering temperature required to complete the decomposition process. Thermal studies can provide an evidence for the eradication of associated solvent and amorphous to crystalline structure transformation. The obtained DSC plots or patterns for different ratios of Ti-Co and Zr-Co powder materials those heated at the rate of 10 °C /min in the nitrogen flowing atmosphere having the temperature range 30 °C to 350 °C with constant supply of pressure are shown in Fig 4(a) (b). The corresponding differential scanning calorimeter (DSC) plots of the Ti+Co material clearly shows, there are four phenomenal exothermal peaks at 82°C, 231°C, 157°C and 152°C these are correlated to the reaction of the getter material with nitrogen gas. However, for the Ti+Co getter material a wide exothermal peak from the temperature 100 °C to 250 °C and a wide endothermic peak in the temperature range from 250°C to 360°C are shown above figure 5. In this the exothermal peak is corresponding to the interacted of nitrogen and metal powder atoms. The endothermic peak is corresponding to decrease the reaction of getter materials, from the results of the experiments on activation treatment and characterization of the samples.

SEM with EDS (EDX) Studies

It is well established that the gas sorption properties of non-evaporable getter materials mostly depend on active specific surface area and diffusion mechanism. The SEM micrographs or photographs and the weight percentage for the present Ti-Co and Zr-Co series of getter materials are shown in Fig 6(a)-(d) , Fig 7(a)-(d) Fig 8(a)-(d) and Fig 9(a)-(d). For the present Titanium typed getter materials, the bulk diffusion is increased with the increase of Ti and decrease of Co contents. Similarly the average grain size also varies with the variation of Ti and Co ratio. The computed grain size values are found to show corroboration with the XRD studies. This confirmed the columnar growth shape of the materials with an average grain size of about 15-18 µm. Conferring to TMD (Thornton–Movchan–Demchisjin) principle the columnar type arrangement originates from atomic shadowing effect and low mobility of atoms [10, 15, 16, 20, 26].

It is also observed that a small porous structure is formed among the grains. This void space structure provides sufficient mechanical strength; increases surface area of the getters and maintain a suitable gas sorption capacity as well [10, 16]. It is observed that the present Ti-Co getter materials seem to show higher capacity of gas sorption in contrast to the crystalline Ti-Co materials. The more surface area of the adsorption materials results to have good adsorption of ambient gases. Consequently it provides more surface reflections and increases the probability of gases trapping [10, 16, 26]. The energy dispersive spectra, qualitative and quantitative results of Ti-Co series of getter materials are shown in the Fig-6(a)-(d). It is observed that EDS shows the appropriate ratios of the elements. In the second series of Zr-Co NEG materials, the gas sorption properties mostly depend on active specific surface area and diffusion mechanism. The SEM micrographs and the weight percentage for the present Zr-Co series of getter materials are shown in Fig 8(a) -(d) and Fig 9(a) - (d). In Zirconium type getter materials, the bulk diffusion is decreased with the increase of Zr and with the increase of Co contents. Similarly, the average grain size also decreases with the increase in Zirconium and with the decrease in Cobalt. The computed grain size values are found to show in corroboration with the XRD studies [10, 20, 26].

It is also observed that both Ti-Co and Zr-Co series show porous structure among the grains. This void space structure provides sufficient mechanical strength; increases surface area of the getters and maintain a suitable gas sorption capacity as well [10, 16]. It is observed that the present Ti-Co and Zr-Co getter materials seem to show higher capacity of gas sorption in contrast to the crystalline of this NEG materials. The more surface area of the adsorption materials results to have high quality sorption of ambient gases. Consequently it provides more surface reflections and increases the probability of gases trapping [10,21,25, 26]. The energy dispersive spectra, qualitative and quantitative results of Ti-Co and Zr-Co series of getter materials are shown above figures. It is observed that EDS shows the both Ti-Co and Zr-Co series appropriate ratios of the elemental line are present Oxygen, Aluminium, Silicon and Carbon. In the EDS find out the weight percentage of Oxygen is very high in the both series may be the material oxidised when the grinding process. Also the remaining of Al,Si and C weight percentage are less from the EDS tables.





CONCLUSIONS

- Cubic structured Ti-Co and Zr-Co series getter materials are well prepared by simple solid state route at 1000 °C for 2 hours and the sorption, phase formation and morphological studies are analysed.
- The structure, composition and morphology nature of the synthesized materials are characterized by TG/DSC, XRD and SEM with EDS techniques. These Ti-Co and Zr-Co getter materials found to show good crystalline nature exhibiting cubic structure.
- The TG/DSC studies reveal the temperature dependence of the getter material properties. All the TG plots facilitate to observe the activation and sorption process of the both materials. Above 500 °C the sorption properties is increased for all the getter materials of Ti-Co and Zr-Co series.
- SEM analysis reveals the varying porosity of the indicating the change in the sorption behaviour of materials due to change in the Ti-Co and Zr-Co contents. EDX spectra confirmed the presence of elements as major one in the present both series of getter materials.

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Table 1: Composition of Ti-Co and Zr+Co getter materials.

S.No	Composition Material (mg) Series-1	Composition Material (mg) Series-2	Activation Temp. (°C)	Activation Time (min)
1	Ti ₆₄₀ Co ₃₆₀	Zr ₆₄₀ Co ₃₆₀	1000	120
2	Ti ₆₈₀ Co ₃₂₀	Zr ₆₈₀ Co ₃₂₀		
3	Ti ₇₂₀ Co ₂₈₀	Zr ₇₂₀ Co ₂₈₀		
4	Ti ₇₆₀ Co ₂₄₀	Zr ₇₆₀ Co ₂₄₀		
5	Ti ₈₀₀ Co ₂₀₀	Zr ₈₀₀ Co ₂₀₀		

Table 2: Lattice parameter (a), Unit cell volume and Crystallite size values of synthesized Ti-Co getter materials.

Material (mg)	Lattice Parameter "a" / (Å)	Unit Cell Volume / (Å) ³	Crystallite Size from (100) / (nm)
Ti ₆₄₀ Co ₃₆₀	3.2240	33.5120	3.42
Ti ₆₈₀ Co ₃₂₀	2.9729	26.2774	3.43
Ti ₇₂₀ Co ₂₈₀	2.9847	26.7168	3.48
Ti ₇₆₀ Co ₂₄₀	2.9911	26.7609	2.62
Ti ₈₀₀ Co ₂₀₀	3.0102	27.2766	2.62





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Table 3: Lattice parameter (a), Unit cell volume and Crystallite size values of synthesized Zr-Co getter materials.

Material (mg)	Lattice Parameter "a" / (Å)	Unit Cell Volume / (Å) ³	Crystallite Size from (100) / (nm)
Zr ₆₄₀ Co ₃₆₀	3.3255	36.7765	90.95
Zr ₆₈₀ Co ₃₂₀	3.2732	35.0685	67.07
Zr ₇₂₀ Co ₂₈₀	3.3686	38.2250	48.38
Zr ₇₆₀ Co ₂₄₀	3.2291	33.6701	21.23
Zr ₈₀₀ Co ₂₀₀	3.2821	35.3553	18.55

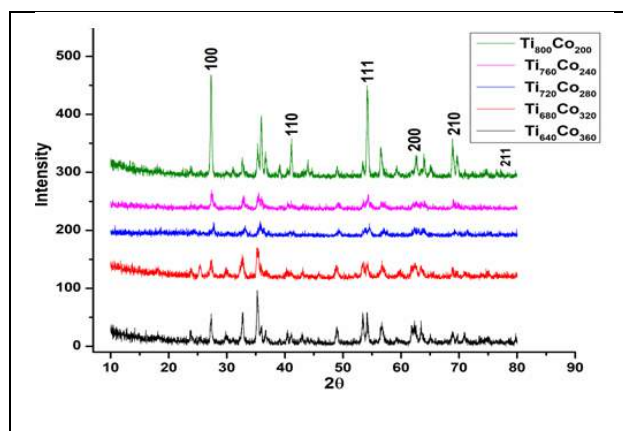


Fig 1: XRD patterns of Ti-Co series alloys.

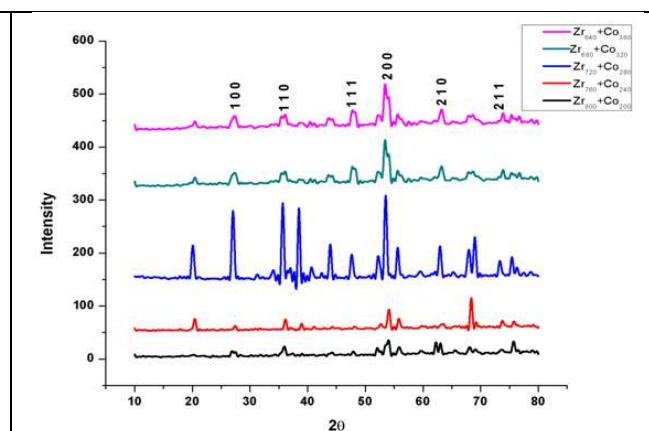
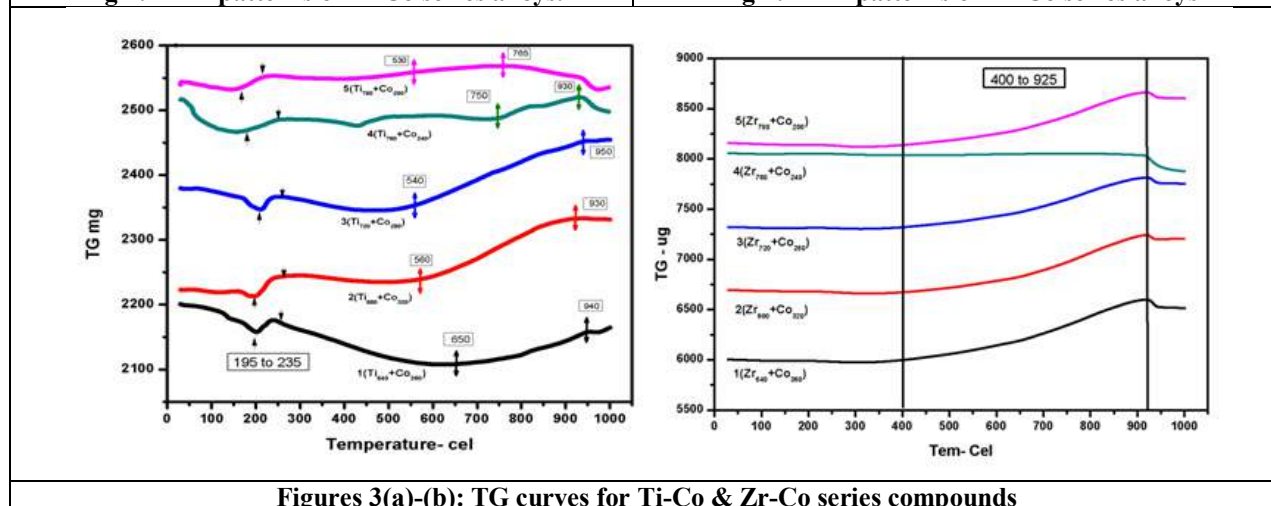


Fig 2: XRD patterns of Zr-Co series alloys

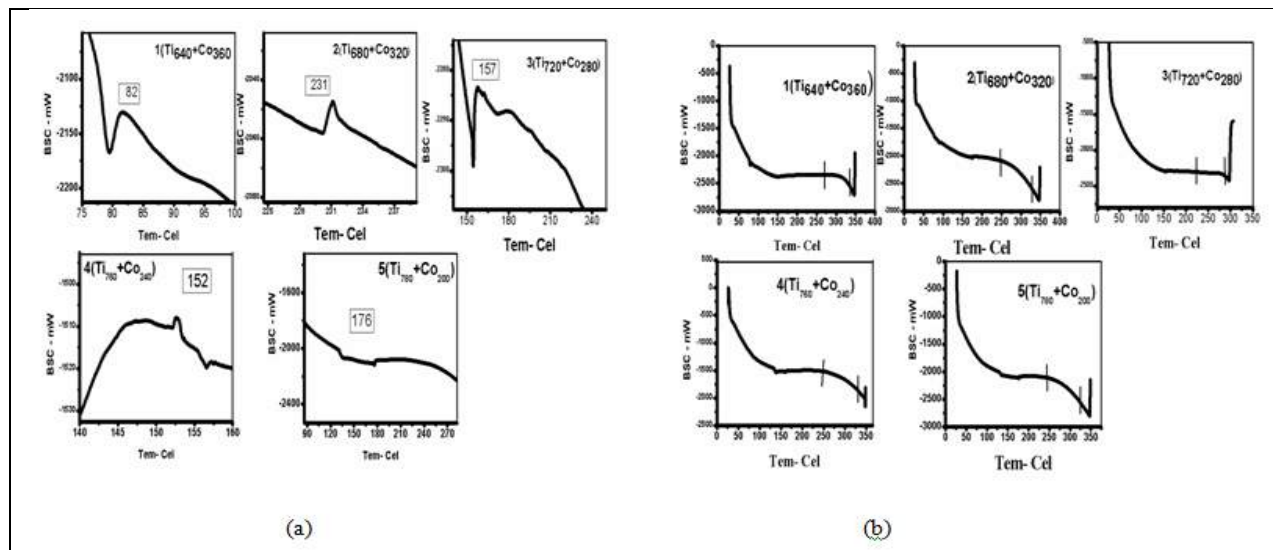


Figures 3(a)-(b): TG curves for Ti-Co & Zr-Co series compounds

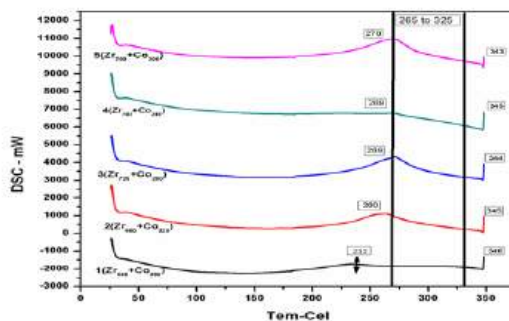




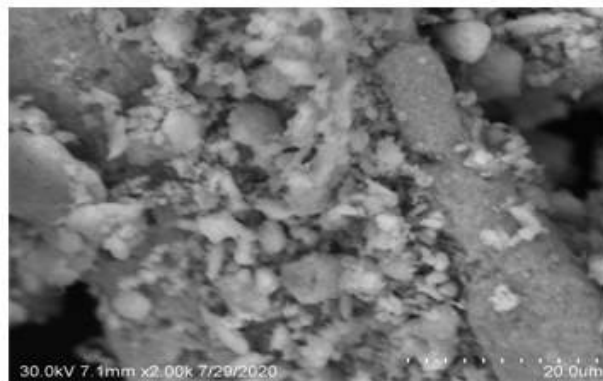
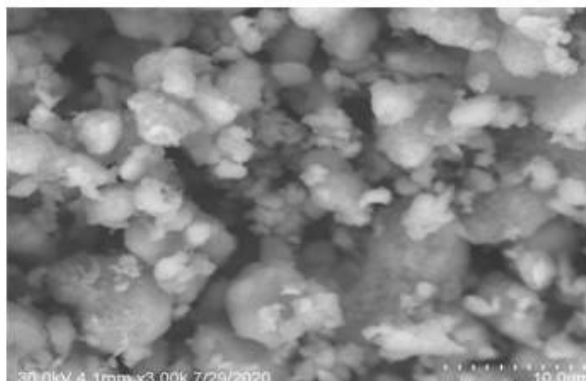
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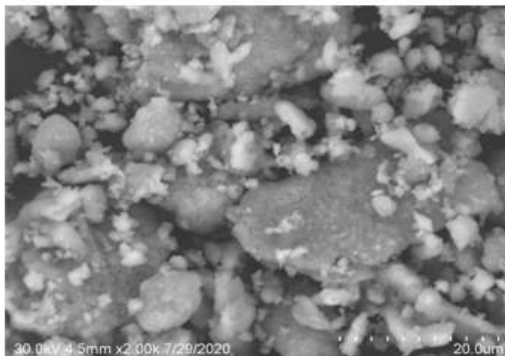
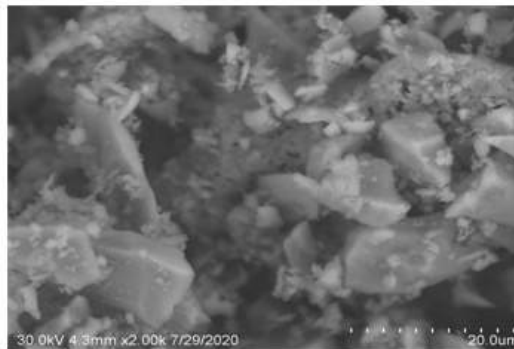


Figures 4(a)-(b): DSC curves for Ti-Co series compounds.



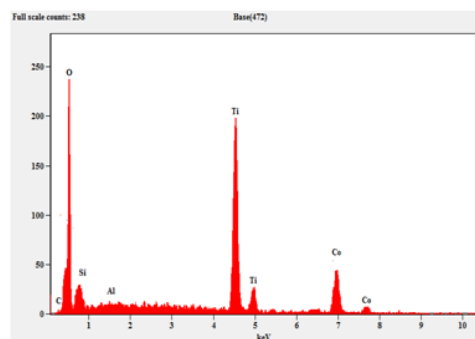
Figures 5: DSC curves for Ti-Co series compounds.

(a) Ti₆₄₀Co₃₆₀(b) Ti₆₈₀Co₃₂₀

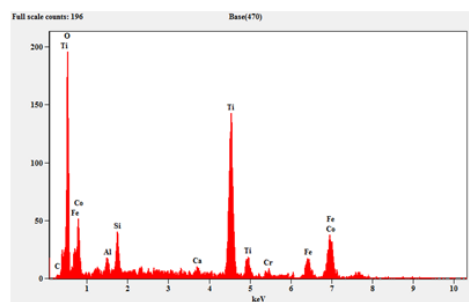
(c) Ti₇₆₀Co₂₄₀(d) Ti₈₀₀Co₂₀₀

Figures 6(a)-6(d): SEM images of Ti-Co series alloys

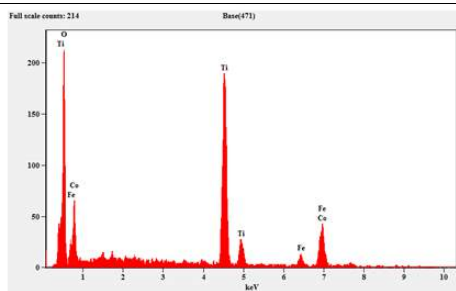
Element Line	Weight %	Weight % Error	Atom %
C K	27.93	±2.04	51.92
O K	16.16	-----	22.55
Al K	1.81	±0.26	1.50
Si K	3.44	±0.26	2.73
Si L	----	-----	----
Ti K	32.19	±1.14	11.28
Ti L	----	-----	----
Co K	26.46	±1.76	10.02
Co L	----	-----	----
Total	100.00		100.00

(a) Ti₆₄₀Co₃₆₀

Element Line	Weight %	Weight % Error	Atom %
C K	6.86	±1.71	17.23
O K	20.37	-----	38.43
Al K	1.74	±0.23	1.94
Si K	3.19	±0.40	3.43
Ca K	0.99	±0.19	0.75
Ti K	30.50	±1.05	19.22
Cr K	1.74	±0.37	1.01
Fe K	9.22	±0.87	4.99
Co K	25.38	±2.34	13.00
Total	100.00		100.00

(b) Ti₆₈₀Co₃₂₀

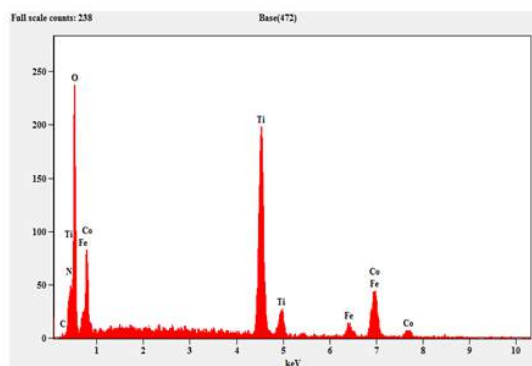
Element Line	Weight %	Weight % Error	Atom %
O K	27.25	-----	54.92
Ti K	40.80	±1.11	27.46
Ti L	----	-----	----
Fe K	4.47	±0.75	2.58
Fe L	----	-----	----
Co K	27.48	±1.54	15.03
Co L	----	-----	----
Total	100.00		100.00

(c) Ti₇₆₀Co₂₄₀

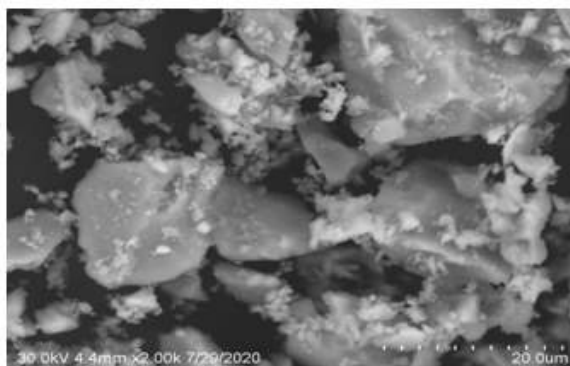
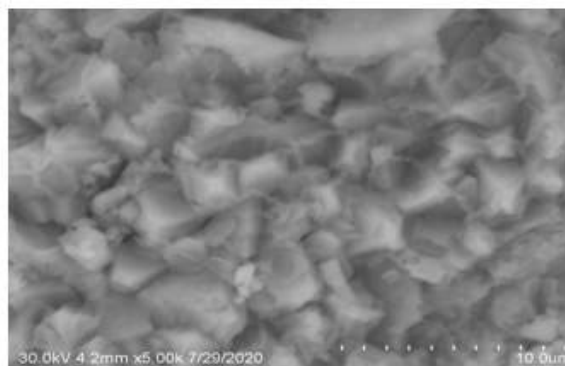
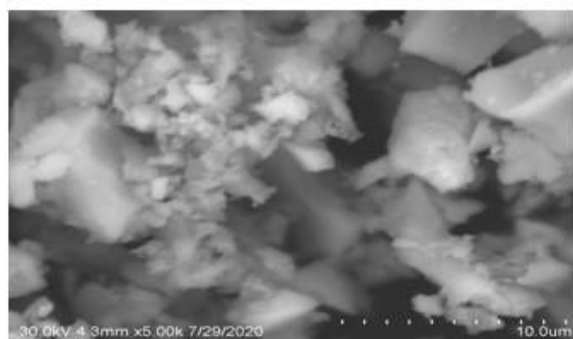
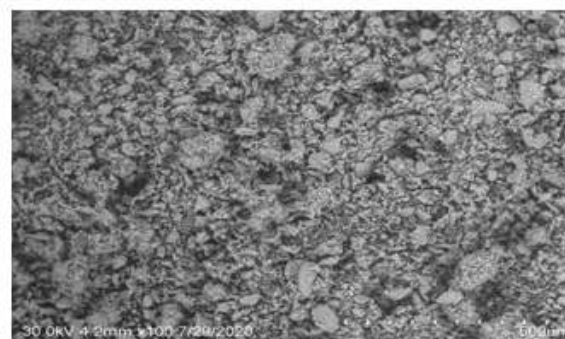


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Element Line	Weight %	Weight % Error	Atom %
C K	10.13	±1.09	17.65
N K	29.22	±2.07	43.62
O K	15.95	-----	20.85
Ti K	23.88	±0.66	10.42
Ti L	-----	-----	-----
Fe K	3.63	±0.04	1.36
Fe L	-----	-----	-----
Co K	17.19	±0.92	6.10
Co L	-----	-----	-----
Total	100.00		100.00

(d) Ti₈₀Co₂₀

Figures 7(a)-(d): EDS spectra and elemental composition of all the materials analysed by (weight %), (atomic %) for Ti-Co series alloys

(a) Zr₆₄Co₃₆(b) Zr₆₈Co₃₂(c) Zr₇₆Co₂₄(d) Zr₈₀Co₂₀

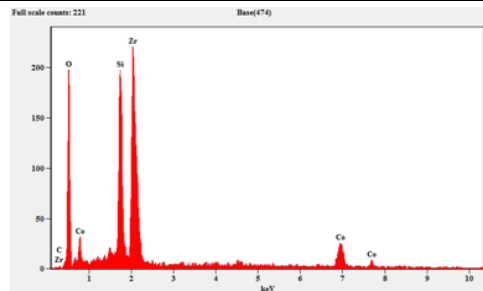
Figures 8(a)-(d): SEM images of Zr-Co series alloys.



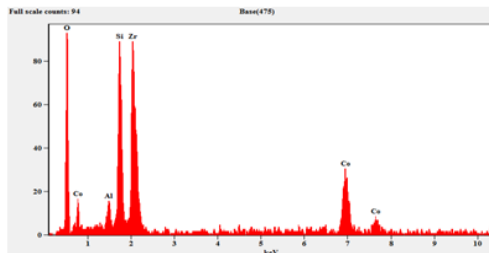


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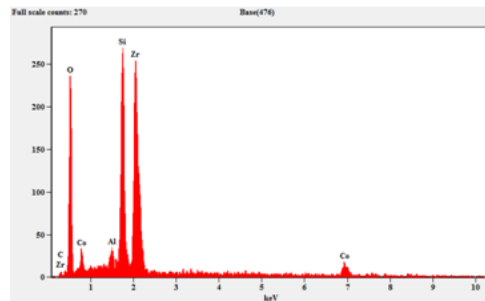
Element Line	Weight %	Weight % Error	Atom %
O K	46.16	±0.98	75.71
C K	0.00	-----	0.00
Si K	10.49	± 0.49	9.80
Si L	-----	-----	-----
Co K	12.88	± 1.04	5.73
Co L	-----	-----	-----
Zr L	30.47	±1.39	8.76
Zr M	-----	-----	-----
Total	100.00		100.00

(a) Zr₆₄₀+Co₃₆₀

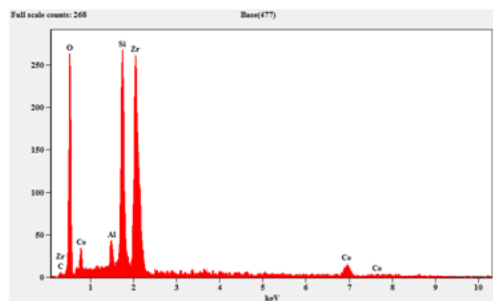
Element Line	Weight %	Weight % Error	Atom %
O K	32.09	±1.58	61.53
Al K	1.88	±0.27	2.13
Si K	11.57	± 0.74	12.64
Si L	-----	-----	-----
Co K	29.17	± 1.99	15.19
Co L	-----	-----	-----
Zr L	25.29	±1.87	8.51
Zr M	-----	-----	-----
Total	100.00		100.00

(b) Zr₆₈₀+Co₃₂₀

Element Line	Weight %	Weight % Error	Atom %
C K	0.00	---	0.00
O K	49.35	±1.58	77.13
Al K	0.94	±0.17	0.87
Si K	12.09	± 0.48	10.76
Si L	-----	-----	-----
Co K	6.18	± 0.76	2.62
Co L	-----	-----	-----
Zr L	31.44	±1.32	8.62
Zr M	-----	-----	-----
Total	100.00		100.00

(c) Zr₇₆₀+Co₂₄₀

Element Line	Weight %	Weight % Error	Atom %
C K	0.00	---	0.00
O K	50.56	±0.95	77.88
Al K	1.44	±0.16	1.32
Si K	11.53	± 0.45	10.12
Si L	-----	-----	-----
Co K	5.61	± 0.75	2.35
Co L	-----	-----	-----
Zr L	30.85	±1.25	8.34
Zr M	-----	-----	-----
Total	100.00		100.00

(d) Zr₈₀₀+Co₂₀₀

Figures 9(a)-(d): EDS spectra and elemental composition of all the materials analysed by (weight %), (atomic %) for Ti-Co series alloys.





MRI and CT in Optometry: A Critical Knowledge Base for Detecting Eye Anomalies

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ABSTRACT

Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) have emerged as essential diagnostic and therapeutic tools for ocular tumors and abnormalities. This study highlights how crucial it is for optometrists to understand MRI and CT imaging methods in order to support the timely identification and precise diagnosis of ocular disorders. Optometrists can greatly enhance patient outcomes by being aware of the special qualities and diagnostic potential of various imaging modalities. This study explores the functions, benefits, drawbacks, and ways that MRI and CT scans supplement optometric exams in the diagnosis of ocular tumors and anomalies. Beyond the scope of standard optometric examinations, MRI and CT provide deep insights into ocular structures that have made them indispensable instruments in the diagnosis of ocular malignancies and anomalies [1, 2]. Optometrists are the first healthcare professionals patients should see for eye health issues, and they are vital to the early diagnosis and treatment of ocular disorders [3]. Therefore, in order to increase diagnostic accuracy, facilitate appropriate referrals, and improve patient outcomes, optometrists must possess a thorough understanding of MRI and CT imaging. In order to identify a variety of ocular malignancies, including retinoblastoma, choroidal melanoma, and optic nerve glioma, as well as anomalies such as optic nerve hypoplasia and coloboma, optometrists must become knowledgeable with MRI and CT imaging techniques [4, 5]. This study illustrates how MRI provides superior soft tissue contrast, making it especially useful for diagnosing intraocular malignancies and optic nerve disorders [6]. It does this by evaluating recent literature and analyzing clinical case studies. On the other hand, CT is an invaluable



**Nagula Dinesh Kumar et al.,**

tool for identifying orbital fractures and calcified lesions because it offers superb visibility of bone structures and calcifications. To sum up, in order to be at the forefront of eye care and to work in tandem with radiologists and ophthalmologists, optometrists must become proficient in MRI and CT imaging. In the end, this integration will result in better patient care and diagnostic capacities for the treatment of ocular cancers and aberrations.

Keywords: MRI, CT, Optometry, Ocular Tumors, Ocular Anomalies

INTRODUCTION

Because ocular tumors and anomalies are so complex and delicate, diagnosing and treating them can be quite difficult. Even if they work well, traditional optometric methods occasionally don't provide enough detailed diagnostic data. These days, MRI and CT imaging are very strong instruments that provide comprehensive information on the architecture of the eyes, making them crucial for identifying problems related to the eyes [7, 8]. The requirement for optometrists to become knowledgeable in the interpretation of various imaging modalities has grown in the last few years. This study investigates the necessity for this, the possible advantages of MRI and CT in optometric practice, and the ways in which these modalities can improve the precision of ocular tumor and anomaly diagnosis [9, 10]. Anomalies and tumors of the eyes can range from benign diseases to deadly cancers. For care and therapy to be effective, an accurate and timely diagnosis is essential because a delayed diagnosis can lead to blindness or the systemic spread of cancerous disorders [11]. To assess ocular anatomy, optometrists have historically used ophthalmoscopy, visual field testing, and slit-lamp biomicroscopy. Nevertheless, the capacity of these techniques to identify underlying anomalies or gauge the severity of specific ailments may be restricted [12]. Because they allow for a detailed picture of the orbital and ocular structures, advanced imaging techniques such as MRI and CT have completely changed the field of ocular diagnostics. Although radiologists are the ones who interpret these modalities most often, an optometrist's comprehension and recognition of important imaging aspects can greatly enhance patient care, especially when it comes to diagnosing diseases that need immediate attention.

Objectives

- To understand the role of MRI and CT in identifying ocular tumors and anomalies.
- To emphasize how crucial it is for optometric practice to incorporate knowledge of MRIs and CT scans.
- To discuss the potential improvements in patient outcomes with the use of MRI and CT imaging.
- To comprehend how MRI and CT work together to detect abnormalities and tumors in the eyes.

MATERIALS AND METHODS

This study included a thorough analysis of the body of research on the identification of ocular tumors and abnormalities using MRI and CT imaging. To evaluate these imaging modalities' efficacy, a number of case studies were examined. To find out how knowledgeable and at ease they were in reading MRI and CT scans, a survey of optometrists with different degrees of expertise was conducted. Peer-reviewed publications, optometric associations, and medical databases like PubMed and ScienceDirect were the sources of the data. The value of MRI and CT imaging in optometric practice was assessed through quantitative and qualitative analysis. The study was approved ethically, guaranteeing the privacy and security of each and every participant.

RESULTS AND DISCUSSION

The findings of the investigation indicate that MRI and CT imaging are essential for the diagnosis of ocular tumors and abnormalities, particularly in cases when other diagnostic techniques are unsatisfactory.



**Nagula Dinesh Kumar et al.,****MRI in Ocular Diagnosis**

Since MRI offers precise images of soft tissues, it is very helpful in locating tumors, inflammations, and abnormalities inside the eye. Its non-invasiveness and capacity to generate high-contrast images render it a highly effective instrument for the identification of disorders such as ocular melanoma, optic nerve glioma, and retinoblastoma [13].

Superior Soft Tissue Contrast and Resolution

The remarkable soft tissue contrast of magnetic resonance imaging (MRI) makes it possible to clearly see the internal structures of the eye, including the retina, optic nerve, extraocular muscles, and surrounding orbital tissues. This is one of the main advantages of MRI [14]. This is especially helpful in the diagnosis of orbital illnesses, optic nerve problems, and intraocular malignancies. For instance, MRI is very useful in diagnosing and describing disorders like optic neuritis and optic nerve gliomas, which, if untreated, can cause severe vision impairment. The distinctive "tram-track" sign, which denotes thickening of the optic nerve sheath, can be clearly seen on MRI in cases of optic nerve sheath meningioma. For optometrists, this kind of accurate visualization is essential for assessing the severity of the condition and enabling prompt referral for specialist care [15].

Detection of Ocular Tumors

MRI is a vital diagnostic tool for ocular cancers, such as hemangiomas, retinoblastomas, and choroidal melanoma. It provides comprehensive information on the location, size, and form of tumors, which helps with precise staging and treatment planning [16]. Because MRI is non-ionizing and safe for repeated imaging, it is chosen over other imaging modalities in pediatric cases of retinoblastoma. It is essential for establishing the prognosis and possible treatment approaches since it may identify tiny intraocular masses and assess the degree of optic nerve involvement. The most prevalent primary intraocular cancer in adults, choroidal melanoma, might be difficult to identify with just a standard examination. With the help of high-contrast MRI images, which distinguish the tumor from the surrounding ocular tissues, optometrists can detect tumors early on and work in tandem with oncologists to ensure timely care [17].

Evaluation of Orbital Anomalies and Trauma

MRI is a vital diagnostic tool for orbital trauma or anomalies since it can be used to evaluate soft tissue injuries, muscle involvement, and optic nerve injury. It is especially helpful in diagnosing hematomas, orbital fractures, and entrapment of extraocular muscles [18]. MRI is more skilled at detecting soft tissue injuries and evaluating any sequelae such as orbital cellulitis or abscess formation, even though CT scans are frequently the primary option for analyzing bony structures in orbital trauma cases. Recognizing these abnormalities is essential for optometrists in order to make the right referrals and guarantee that patients receive full care.

Diagnosing Inflammatory and Degenerative Conditions

Because MRI is so sensitive to changes in the composition of soft tissues, it is a great way to diagnose inflammatory disorders such as sarcoidosis, thyroid eye disease, and orbital pseudo tumors [19]. During normal optometric exams, these disorders might be difficult to identify since they frequently present with nonspecific symptoms. MRI's capacity to identify muscle hypertrophy, tissue edema, and inflammation aids optometrists in differentiating between various illnesses, facilitating precise diagnosis and treatment.

Safety and Non-Invasive Nature

The fact that MRI does not involve ionizing radiation makes it a safer imaging modality, particularly for patients who are pregnant or have young children. This is especially important when it takes several imaging sessions to track the development of eye problems over time. In order to ensure patient safety and provide recommendations for imaging modalities, optometrists must have a thorough awareness of this safety profile.

Identifying Vascular Abnormalities and Hemorrhages

Vascular anomalies such as cavernous hemangiomas, arteriovenous malformations, and venous thrombosis can be found with MRI, especially when contrast is added. During normal examinations, optometrists can initially identify





indications of these disorders, which may include proptosis or alterations in vision. Correlating MRI results with clinical symptoms can greatly increase diagnostic precision and make proper therapy easier.

CT in Ocular Diagnosis

Rapid imaging capabilities are provided by CT scans, which are especially helpful in identifying calcifications and anomalies in the bone surrounding the eyes. When diagnosing disorders including choroidal osteoma, orbital fractures, and optic nerve sheath meningioma, CT imaging is helpful [8].

Superior Bone Detail and Assessment of Orbital Fractures

CT imaging is the preferred modality for identifying orbital fractures because of its unique advantages in assessing bony structures. CT can give optometrists a thorough image of the orbital bones in trauma cases, such as sports injuries, accidents, or physical assaults. This view might help them identify fractures that could go undetected during a standard examination [20]. It can also detect any entrapment of the extraocular muscles and fractures of the orbital roof, walls, or floor. For example, a "blowout fracture," in which an abrupt trauma fractures a portion of the orbital wall, is a common condition that can be seen by CT imaging. With the ability to quickly identify fractures based on CT results, optometrists can refer patients to maxillofacial surgeons or ophthalmologists for additional care. This allows for prompt treatment and avoids long-term complications like enophthalmos, or the appearance of sunken eyes [21].

Detection of Calcifications in Ocular Tumors

When it comes to identifying calcifications within ocular malignancies, computed tomography (CT) is a highly useful diagnostic tool that can help inform treatment choices [22]. For instance, intraocular calcifications that are easily detected on a CT scan are frequently present in cases of retinoblastoma, a malignant eye tumor that is most frequently observed in youngsters. Since retinoblastoma can grow quickly and endanger life and eyesight, early discovery of these calcifications is essential for timely diagnosis and treatment. Similarly, by identifying distinctive calcification patterns, CT imaging can assist in distinguishing benign from malignant lesions in adults, such as choroidal osteomas or optic nerve sheath meningiomas. The fact that traditional optometric examination methods frequently fall short of providing this level of information highlights the significance of CT imaging in the diagnostic process [23].

Evaluation of Orbital and Ocular Masses

When it comes to detecting and assessing orbital tumors such as lymphomas, dermoid cysts, and cavernous hemangiomas, CT imaging is crucial [24]. It offers distinct pictures of the mass's dimensions, form, and relationship to neighboring structures—information that is essential for choosing the best course of action. The ability to identify these masses on CT can help optometrists accurately refer patients to specialists, ensuring that patients receive the necessary care. For instance, dermoid cysts can be recognized on CT scans by their distinctive appearance, which usually consists of fat, calcifications, or fluid. These cysts commonly show as slowly developing, painless orbital masses. By identifying these characteristics, optometrists can accurately diagnose and treat patients by distinguishing between benign cysts and potentially malignant tumors.

Assessment of Inflammatory Conditions and Infections

When detecting orbital cellulitis, an acute bacterial infection of the tissues surrounding the eye, CT imaging is helpful. If this illness spreads to the brain, it might be fatal, thus prompt detection and treatment are crucial. By determining the degree of the infection, identifying any abscess formation, and evaluating paranasal sinus involvement, CT scans can help determine the best course of action for treatment, which may include surgery or antibiotics. CT can show the enlargement of extraocular muscles and identify any expansion of orbital fat or compression of the optic nerve in cases with thyroid eye disease (TED). Optometrists who are knowledgeable about these CT results can be quite helpful in identifying and tracking TED, guaranteeing prompt treatment, and averting consequences like optic neuropathy.



**Nagula Dinesh Kumar et al.,****Quick and Effective Imaging for Emergency Situations**

Because CT scans provide speedy imaging, they are the best option when making immediate decisions in an emergency. A CT scan can be finished in a matter of minutes, but an MRI can take thirty to sixty minutes, and it can provide diagnostic results right away. In cases of orbital damage, suspected foreign bodies, or acute hemorrhages, where delays in diagnosis can lead to problems that could endanger vision, this speed is especially helpful.

Detection of Intraocular and Intraorbital Foreign Bodies

CT is very useful in identifying and localizing foreign bodies in cases when patients have a history of ocular trauma with possible penetration, particularly if the objects are metallic or radiopaque. Planning a surgical removal and halting additional harm to the ocular structures require this information.

Comparison between MRI and CT

- Benefits of MRI imaging include better soft tissue contrast, high resolution pictures, and no radiation exposure.
- Benefits of CT imaging include faster imaging times, superior bone resolution, and improved calcification visualization.
- Limitations: While CT requires radiation exposure, MRI is less useful in identifying bone problems.

Improved soft tissue contrast, high-resolution images, and no radiation exposure are some advantages of MRI imaging. Faster imaging speeds, better bone resolution, and enhanced calcification visualization are some advantages of CT imaging.

Limitations: MRI is less effective in detecting bone issues than CT, which exposes users to radiation.

Discussion on Integrating MRI and CT Knowledge

It is quite beneficial for optometrists to comprehend MRI and CT imaging. Better patient education, more precise referrals to ophthalmologists, and early identification of potentially fatal disorders are all made possible by it. Workshops, cooperative training with radiologists, and ongoing education initiatives are examples of integration strategies.

CONCLUSION

The proper diagnosis and timely detection of ocular cancers and anomalies depend on the integration of MRI and CT imaging information in optometric practice. These imaging techniques will eventually supplement conventional optometric evaluations as they develop further. According to this study, optometrists should be taught MRI and CT interpretation techniques in order to give them the tools they need to interpret these pictures correctly. Optometrists can be more proactive in recognizing and controlling ocular diseases by developing a thorough understanding of MRI and CT imaging. This will ultimately improve patient outcomes and the standard of care provided by the eye care clinic. This study emphasizes how important it is for optometrists to gain a basic understanding of CT and MRI imaging. Better patient outcomes can be achieved by optometrists by utilizing this knowledge to enhance their diagnostic abilities in optometric education and practice. Maintaining knowledge and expertise in these modalities will be crucial for offering complete eye care as imaging technology develops.

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Impact of National Educational Policy on Engineering Education in Indian Universities (2021-2024): Case Studies

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ABSTRACT

The National Education Policy (NEP) 2020, introduced by the Government of India, aims to transform the educational landscape of the country. This article explores the impact of NEP on engineering education in Indian universities from 2021 to 2024, with a focus on case studies from premier institutions such as IIT Madras, Visvesvaraya Technological University (VTU), and Manipal Academy of Higher Education (MAHE). The NEP's emphasis on multidisciplinary learning, research, industry collaboration, and digital education has brought about substantial changes in the engineering education framework. The study reveals that engineering institutions have adopted a more flexible and interdisciplinary approach, integrating subjects from humanities, management, and social sciences to produce well-rounded graduates. Research output has significantly increased, with universities establishing dedicated research centers and enhancing collaborations with industries and international partners. Additionally, the NEP's push for skill development, vocational training, and digital learning tools has improved employability and access to quality education. The article employs a mixed-method approach, combining quantitative data analysis with qualitative insights, to assess the impact of NEP on engineering education. Key metrics such as the number of multidisciplinary courses, industry partnerships, research projects, employment rates, and international collaborations were examined. The findings suggest that NEP 2020 has been instrumental in reshaping engineering education, making it more aligned with the demands of the modern world. This article concludes that NEP's influence has significantly improved the quality, flexibility, and global competitiveness of engineering education in India.

Keywords: NEP 2020, industry partnerships, research projects, employment rates, international collaborations.





INTRODUCTION

The Indian education system has undergone numerous reforms over the years, but the introduction of the National Education Policy (NEP) 2020 marks a pivotal change, particularly in the context of higher education. NEP 2020 is a comprehensive policy that aims to transform India's education sector by promoting holistic, multidisciplinary, and flexible learning environments. Engineering education, which plays a crucial role in India's technological and industrial growth, has seen a remarkable transformation in the period from 2021 to 2024 due to the implementation of NEP 2020.

Objectives of NEP 2020 and Relevance to Engineering Education:

NEP 2020 seeks to break down the silos of traditional education by promoting multidisciplinary studies, research, and industry collaboration. For engineering education, this means integrating humanities, social sciences, and management subjects into the core curriculum. The policy also emphasizes experiential learning, internships, digital education, and global exposure, making Indian engineering graduates more versatile and employable [Sharma, A., & Gupta, P. (2022)].

Engineering universities across India have begun restructuring their curriculum and introducing innovative teaching methods to align with NEP's objectives. This article examines the effects of NEP 2020 on engineering education in Indian universities, with a focus on three key case studies: IIT Madras, VTU, and MAHE. These institutions provide insights into how the policy has shaped different aspects of engineering education, including curriculum design, research output, industry engagement, and digital learning [Rao, K., & Mehta, S. (2023)].

NEP 2020's Influence on Key Aspects of Engineering Education

Multidisciplinary Approach: Traditionally, engineering education in India has been highly specialized, but NEP 2020 encourages the integration of diverse subjects, fostering creativity and problem-solving skills. Universities are now offering minors in economics, psychology, and management, allowing students to develop a more comprehensive skill set.

Enhanced Research and Innovation: NEP 2020 emphasizes research as a cornerstone of higher education, leading to increased funding, establishment of research centers, and collaboration with industries. Engineering institutions are focusing more on emerging fields like artificial intelligence, robotics, renewable energy, and sustainable technologies.

Industry Collaboration and Internship Opportunities: The policy encourages stronger ties between academia and industry, resulting in more internships, hands-on projects, and job placements. This has bridged the gap between theoretical knowledge and practical application, enhancing students' readiness for the job market.

Digital and Online Learning: The COVID-19 pandemic accelerated the adoption of digital education, and NEP 2020 has further catalyzed this shift. Universities are incorporating online courses, e-learning platforms, and blended learning methods to provide more accessible and flexible education.

Skill Development and Vocational Training: To make engineering education more practical and relevant, NEP 2020 encourages vocational training and skill development courses. This approach prepares students for a dynamic job market and enhances their employability.





METHODOLOGY

The study adopts a mixed-method research approach, combining quantitative data analysis with qualitative insights. The research focuses on three case studies: IIT Madras, VTU, and MAHE, which represent diverse geographical, institutional, and academic contexts in India.

Data Collection

Quantitative Data: Statistical data from university reports, government publications, and research papers from 2021 to 2024 were collected. Key metrics such as the number of multidisciplinary courses, industry partnerships, research projects, online courses, and employment rates were analyzed.

Qualitative Data: Interviews with faculty, administrators, and students, along with reports from university websites and media sources, provided qualitative insights.

Data Analysis

Quantitative data were analyzed using statistical tools to identify trends and changes over time.

Qualitative data were thematically analyzed to understand the perceptions and experiences of stakeholders regarding the impact of NEP 2020.

RESULTS

Case Study 1: IIT Madras

Table 1: Key Metrics at IIT Madras (2021-2024) & Figure 1 Growth in Research Projects at IIT Madras (2021-2024)

Case Study 2: VTU

Table 2: VTU's Implementation of NEP (2021-2024) & Figure 2: Employment Rate of VTU Graduates (2021-2024)

Case Study 3: MAHE:

Table 3: Research and International Collaboration at MAHE (2021-2024) & Figure 3: Growth in International Collaborations at MAHE (2021-2024)

CONCLUSIONS

The NEP 2020 has had a transformative impact on engineering education in Indian universities from 2021 to 2024. The adoption of multidisciplinary approaches, emphasis on research, industry collaboration, and digital learning has redefined the educational landscape, making it more holistic and future-ready. The integration of practical skills, vocational training, and enhanced international collaborations has improved the employability and global competitiveness of Indian engineering graduates. The case studies demonstrate that NEP 2020 has successfully initiated a paradigm shift, and its continued implementation is likely to propel India's engineering education to new heights.

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Case Study 1: IIT Madras**Table 1: Key Metrics at IIT Madras (2021-2024)**

Metric	2021	2022	2023	2024
Multidisciplinary courses offered	10	15	25	30
Industry collaborations	50	70	90	110
Funded research projects	100	130	170	200

Case Study 2: VTU**Table 2: VTU's Implementation of NEP (2021-2024)**

Metric	2021	2022	2023	2024
Vocational course enrollment	300	500	800	1200
Online courses offered	20	35	50	70
Graduate employment rate (%)	60%	65%	70%	75%

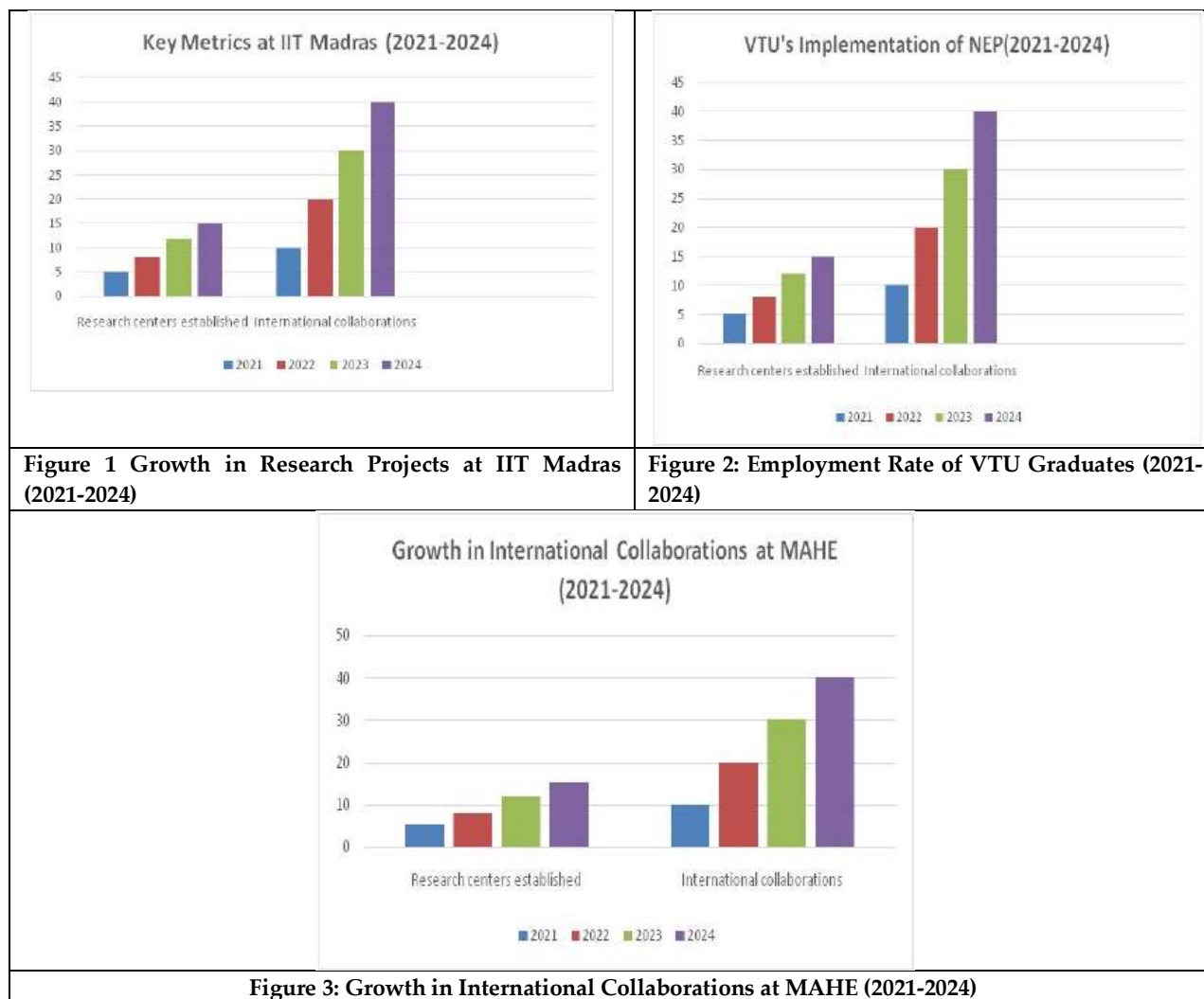
Case Study 3: MAHE:**Table 3: Research and International Collaboration at MAHE (2021-2024)**

Metric	2021	2022	2023	2024
Research centers established	5	8	12	15
International collaborations	10	20	30	40





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Determination of Toxicity of Lead Acetate in *Anabas testudineus*

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ABSTRACT

Water contamination is an increasing concern in the twenty-first century, necessitating societal efforts to enhance water quality and mitigate health repercussions. Heavy metal ions are among the most frequently released contaminants, rendering them particularly alarming. Due to their non-biodegradable nature, heavy metals tend to bioaccumulate. Lead (Pb) is a prevalent and hazardous metal in aquatic environments. This study aims to investigate the toxicological effects of lead acetate on *Anabas testudineus* (Bloch). Commonly referred to as Vietnamese Koi, these fish inhabit agricultural fields, puddles, canals, ditches, flushes, small ponds, and lakes. Several of these sources are significantly polluted with heavy metals and other hazardous substances. In vivo toxicity assessments were performed on *A. testudineus* for 96 hours to analyze their behavior and ascertain the median lethal dose (LD₅₀) of lead acetate. Two preliminary trials were undertaken to determine the approximate range for the final lethality test trials. The mortality was documented at 6, 12, 24, 48, 72, and 96 hours of exposure during the final trial. Following the exposure time, different tissues were analyzed for metal accumulation using UV-Visible spectroscopy. The standard curve was determined with a correlation coefficient (R²) of 0.958. The Heavy metal treatment resulted in few behavioral changes such as loss of control, loss of equilibrium, irregular swimming, excessive mucus secretion from the body, and heavy breathing with vigorous opercula movement. For different time ranges different LD₅₀ were recorded. At concentration 3000mg/lit 100% mortality was recorded. The recovery % of heavy metals from the tissues ranged from 5.4% to 44.7% for doses in the range 1700-3000 mg/lit.

Keywords: Heavy metal, lead acetate, water pollution, bioaccumulation.





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INTRODUCTION

The environment is presently contaminated by several chemicals or xenobiotics introduced by humans to satisfy the requirements of contemporary society. Water, soil, air, and agricultural pollution are the most significant concerns of humanity today. The contamination of aquatic environments globally is a persistent and concerning result of both natural and human induced causes which exerts stress on aquatic creatures and has a deleterious effect[1]. The primary contributors to water contamination include sewage, wastewater, industrial effluents, marine disposal, radioactive contaminants, oil spills, subterranean storage leaks, atmospheric deposition, and global warming. Organic matter, nutrients, pharmaceuticals and personal care items, polyfluoroalkyl and perfluoroalkyl substances, biocides, dyes, radionuclides, plastics, nanoparticles, pathogens and heavy metals are some of the principal pollutants of concern. Heavy metals pose a significant hazard to aquatic organisms, as it infiltrates the ecosystem via several pathways. Lead (Pb) is a heavy metal devoid of any nutritional value that contaminates aquatic ecosystems[2]. The majority of lead concentrations present in the environment are attributed to human activity. Pb is a prevalent and hazardous metal in aquatic environments. These metals readily infiltrate the food chain and subsequently participate in the bioaccumulation process [3]. Fish are often utilized in metal accumulation studies due to their ability to store higher metal concentrations which may pose health risks to people consuming them. Certain fish species also serve as markers of contamination[4] [5]. The toxicity of heavy metals to organisms mostly depends on the method of exposure, the absorbed dosage, and the duration of exposure [6] [7]. Heavy metals exert several acute and chronic detrimental effects on multiple human organs. The accumulation of these metals in the human or animal body can lead to several severe health issues, including headaches, hypertension, eyelid edema, nephritis, renal tumours, extensive kidney lesions, cardiovascular diseases, osteoporosis and cancer [8] [9] [10]. Complications of heavy metal poisoning encompass gastrointestinal and renal dysfunction, neurological abnormalities, dermal lesions, vascular impairment, immune system failure, congenital anomalies, and neoplasia[11] [12] [13]. Simultaneous exposure to many metals may result in cumulative effects [14] [15] [16]. Exposure to high doses of heavy metals, particularly mercury and lead, can result in severe consequences such as abdominal colic, haemorrhagic diarrhoea, and renal failure. Elevated levels of lead can impair blood enzymes and the central nervous system[17][18][19]. Low-dose exposure, conversely, presents a subtle and slow risk unless it occurs consistently, with complications including neuropsychiatric disorders such as fatigue and anxiety, as well as detrimental impacts on intelligence quotient (IQ) and cognitive function in children, being diagnosable. The climbing perch (*Anabas testudineus*), locally known as Vietnamese koi, is a freshwater fish predominantly located in swamps, rice fields, tiny rivers, ditches, and ponds that experience flooding or are connected to open waterways. Studies indicate that the climbing perch is a freshwater fish capable of air-breathing, utilizing an air-breathing organ (ABO) for this function. This species was selected for current study because it can be easily raised under laboratory conditions, it fulfills most of the requirements of a model species and is available throughout the year[20] [21] [22].

MATERIALS AND METHODOLOGY

Experimental fish collection and storage

Healthy 100 specimens of freshwater fish *Anabas testudineus* (locally known as koi) were collected from a fish farm in Rajendrapur, Kolkata, West Bengal. They were of the same age of around 2 months and of almost same size (length 6cm $\pm$ 1cm, weight 8gm $\pm$ 1gm). A plastic container was used to transport the fishes to the laboratory with proper covering and frequent agitation. A large aquarium of capacity 30 lits was cleaned thoroughly first with tap water then wiped with alcohol and then again rinsed with distilled water. It was kept to air dry for the day. The next day the fishes were brought and released into it with 30 lits of tap water and kept for 1 week for the fishes to get acclimatized to the new environment. The water was changed after every 24 hours to maintain the dissolved oxygen levels. The fishes were fed with artificial feed equal to 1/10th of their body weight. Unconsumed food and fecal wastes were siphoned off daily. The temperature and pH were recorded and maintained. Since this is an edible fish which is readily available in the market, ethical permissions are not required.





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Chemicals and reagents

Analytical grade Lead Acetate Trihydrate, hydrogen peroxide 30%, sulfuric acid 98% and cadmium chloride were acquired from Merck (India). Surgical knife was purchased from local pharmacy.

Standards preparation

A stock solution of Lead Acetate of concentration 1gm/lit was prepared by dissolving 1gm of Lead Acetate Trihydrate in 1 lit of distilled water in a conical flask. The stock solution was kept under continuous stirring condition in a magnetic stirrer. Then 10 dilutions of 20ml each in the range 5-50mg/lit were prepared and analyzed.

Treatment of the fish with heavy metal

For the preliminary trial, groups of 4 fish were exposed to water treated with lead acetate in the doses 10mg/lit, 13 mg/lit, 15 mg/lit, 20mg/lit, 30mg/lit concentrations closer to LC50 value of PbCl₂ and CdCl₂ as given in earlier studies [23]. After that two groups were exposed to 729mg/lit concentration of CdCl₂ which was the complete mortality concentration of CdCl₂ in 12hr exposure reported earlier. Then they were exposed to 800mg/lit of CdCl₂. Then the fish were treated with different dilutions of lead acetate of concentrations 1500, 1700, 1800, 1900, 2000, 2200 and 3000 mg/lit.

Preparation of Fish Tissues

After 96 hours of exposure the specimens were collected from the water, then weighed and measured before dissection. The liver, gills and muscle tissues were taken for further analysis. The wet weights of the tissues were recorded. Then they were placed in a hot air oven for two hours. Then the dry weights of the tissues were recorded. After that the dried tissues were dissolved in a 2ml solution of 30% hydrogen peroxide and 36N sulfuric acid (ratio 3:1) for digestion for another 2-3 hours. After that the solutions were mixed properly in a vortex and then made up the volume 10ml by adding distilled water. Then the solutions were filtered. After filtration the absorbances were recorded.

Instrumentation

A double beam spectrophotometer of Thermo Fischer Scientific, Evolution 201 with a deuterium lamp, ± 0.8 nm wavelength accuracy and wavelength range 190 to 1100 nm was used for the analysis. Both the spectrometer and lamp were warmed up for at least 15 minutes before starting the measurement. Quartz cuvettes with pathlength 10mm were used for placing the samples.

RESULTS AND DISCUSSION**Standardization of lead acetate**

The maximum absorption of lead acetate was observed around the wavelengths 200-230 nm [24] [25]. For the standardization, absorbances were recorded in this range using dilutions in the concentration ranging from 5-50mg/lit. The calibration curve was prepared in MS Excel given as given in figure 1. The correlation coefficient was 0.958 which suggested that the developed calibration is robust and can be used to determine the concentration of caffeine in unknown samples with great accuracy.

Preliminary treatment of lead acetate

Taking groups of 4 fishes of similar size, they were exposed to doses of 10, 13, 15 and 20 mg/lit of Lead Acetate. The doses were chosen on the basis of the LC50 of Lead in *Anabas Testudineus* and *Oreochromis mossambicus* [23] [24]. 0% mortality was observed in the selected doses after 96 hr. Then the specimens were treated with higher doses of heavy metal. 100, 500, 1000 and 1200 mg/lit and mortality rate was checked after 96 hours which also was 0%.

Treatment with Cadmium Chloride

The proposed LC50 values for Lead acetate for Zebra Fish or Lead Chloride for the same species were crossed long before and due to lack of any supportive study, treatment with cadmium chloride of proposed doses for LC50 of the same species was decided to be conducted. According to a study complete mortality of *A. testudineus* (100%) occurred at 729 ppm within 12hrs of exposure [23]. So, a group was treated with 729 mg/lit CdCl₂ for comparing the data. After 12hrs only 50% mortality was observed and 100% mortality was observed after 24hrs. Thus, the concentration was increased to 800 mg/lit and after 12 hrs of observation 100% mortality was observed as shown in table 1. The results indicate a higher dose of cadmium chloride for complete mortality.



**Amrita Dey et al.,****Final treatment of lead acetate for LC50**

After the results with cadmium chloride the dose of heavy metal treatment was increased. Therefore, the specimens were treated with 1500, 1700, 1800, 1900, 2000, 2200 and 3000 mg/lit and the mortality rate were recorded as given in figure2. The behavior of the fish was also observed. On treatment with higher doses of Lead acetate Behavioral changes were observed. During the study period, changes such as loss of equilibrium and irregular swimming were noted. The experimental animal had been resting at the bottom of the glass aquarium, had gathered in one corner of the tank and was often swimming at the surface. Heavy metal treatment resulted in the fish losing control, excessive mucus secretion from the body, and heavy breathing with vigorous opercula movement.

Determination of accumulation of lead acetate in fish tissues

The body of the specimens appeared whitish due to the deposition of lead on their outer surface. The liver, gills, and muscle tissues were dissected, then digested and the absorbance values of them were observed as given in table 2. From the absorbances, the amount of metal accumulated in tissues were calculated using the standard curve earlier deduced. First the concentration of metal in each sample was deduced from the standard curve, then it was divided by (4 x dry weight of the tissue).

CONCLUSION

The research findings of this study have many theoretical and practical implications. The study provides a set of important implications for researchers and pollution control practitioners. It is important to explore the possibilities of utilizing any positive implications for industrial usage. The study concludes that the lethal concentration of Lead Acetate for the fresh water bloch *Anabas testudineus* is very high compared to lead chloride and cadmium chloride. Thus, humans or the higher animals who feed on these, have a high chance of bioaccumulation of heavy metal toxicity. As these fishes are found in shallow water bodies like in swamps, canals, agricultural fields, ditches, etc. villagers or tribes or people of slum tend to catch these fishes and consume them as it's the cheaper diet option for them. So, this will cause slow accumulation of heavy metals in the humans and thus it might result in heavy metal poisoning over a long period of time. People might get affected by metal poisoning not even knowing. Thus, it is an alarming situation and we should give our full attention to the increasing pollution of water bodies and find suitable techniques to reduce the pollution and also restoring the water quality.

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Table 1: Mortality rate after treatment with cadmium chloride

Sl. No.	Number of fishes exposed	Dose of cadmium chloride (mg/liter)	Mortality % after 6hr	Mortality % after 12hr	Mortality % after 24hr
01.	4	729	25	50	100
02.	4	800	50	100	-

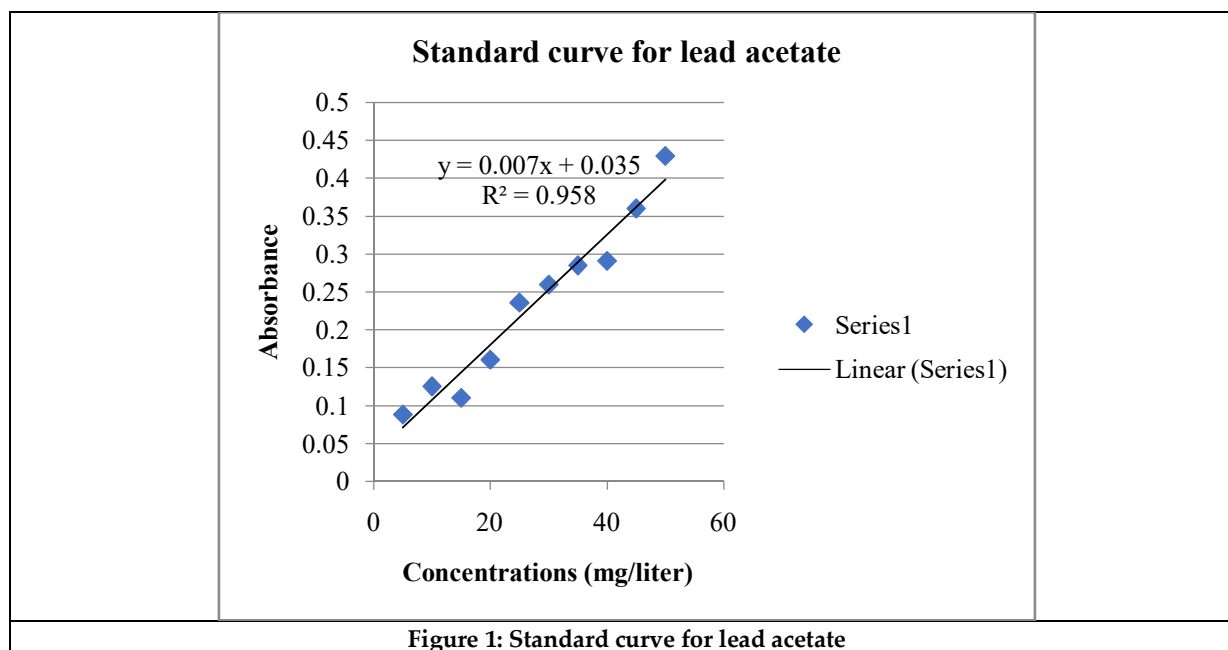




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Table 2: Recovery % of lead acetate from different tissues at different concentrations

Sl. No.	Dose of lead acetate (mg/liter)	Fish tissue	Wet weight	Dry weight	Absorbance	Avg. Accumulation of metal (mg/gm)	Recovery %
01.	1700	Liver	0.452	0.212	3.412	517	30.41176
02.	1700	Gill	0.286	0.154	3.223	673	39.58824
03.	1700	Muscle	2.900	1.201	4.369	117	6.882353
04.	1800	Liver	0.490	0.243	3.436	454	25.22222
05.	1800	Gill	0.282	0.156	3.394	700	38.88889
06.	1800	Muscle	2.794	1.154	4.413	123	6.833333
07.	1850	Liver	0.513	0.254	3.412	432	23.35135
08.	1850	Gill	0.253	0.142	3.423	776	41.94595
09.	1850	Muscle	2.341	1.210	4.402	117	6.324324
10.	1900	Liver	0.594	0.230	3.781	529	27.84211
11.	1900	Gill	0.301	0.160	3.647	734	38.63158
12.	1900	Muscle	2.302	1.101	4.962	145	7.631579
13.	2000	Liver	0.516	0.261	4.123	509	25.45
14.	2000	Gill	0.269	0.156	4.323	894	44.7
15.	2000	Muscle	2.304	1.192	5.661	153	7.65
16.	3000	Liver	0.499	0.234	4.997	689	22.96667
17.	3000	Gill	0.306	0.150	4.823	1038	34.6
18.	3000	Muscle	2.671	1.199	6.016	162	5.4





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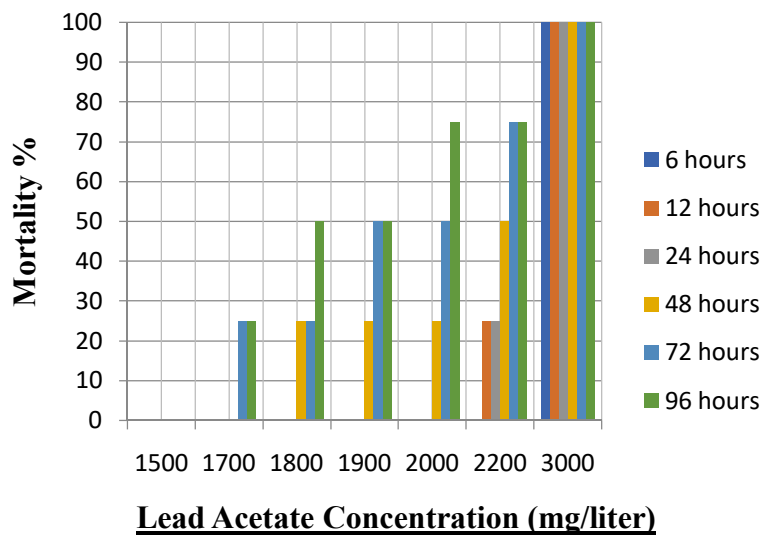


Figure 2: Mortality % Vs. Concentration of Lead Acetate for different time periods





Sports and Exercise: A Statistical Examination of Their Physical, Mental, and Social Benefits

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ABSTRACT

Engagement in sports and exercise is crucial for a healthy lifestyle, offering benefits that extend beyond physical fitness to include mental health and social connectivity. This article presents a statistical examination of the various advantages linked to sports and exercise, utilizing data from numerous international studies and surveys. The analysis encompasses aspects such as cardiovascular health, muscular strength, flexibility, cognitive abilities, mental wellness, and social interactions. Additionally, it discusses trends in participation and emphasizes significant statistics that demonstrate how sports and exercise enhance quality of life.

Keywords: Sports, Exercise, Physical health, Mental health, Strength and flexibility, Stress reduction, Weight management, Discipline, Physical activity

INTRODUCTION

The importance of sports and exercise in promoting both physical and mental health is widely recognized. The World Health Organization (WHO) advises that adults engage in at least 150 minutes of moderate-intensity physical activity each week; however, 1 in 4 adults and 4 in 5 adolescents worldwide fail to achieve this recommendation. Regular involvement in sports not only improves physical health but also cultivates mental strength, cognitive performance, and social cohesion. This article investigates the effects of sports and exercise, underpinned by statistical evidence, to highlight their significance in enhancing overall well-being.



**Binoda Kumar Nayak and Vimal Kar****Purpose of the Study**

This study aims to undertake a thorough statistical analysis of the physical, mental, and social advantages linked to sports and exercise. By examining data from diverse sources, the research intends to furnish empirical evidence that underscores the beneficial effects of physical activity on overall well-being. The investigation will concentrate on three key domains:

Physical Benefits: This segment will investigate how consistent engagement in sports and exercise enhances physical health, mitigates the risk of chronic illnesses, improves cardiovascular fitness, and contributes to increased longevity.

Mental Benefits: This section will assess the impact of physical activity on mental health, including the alleviation of anxiety and depression, enhancements in cognitive abilities, and the role of exercise in stress management and mood elevation.

Social Benefits: Lastly, the study will examine the social benefits derived from participation in sports and exercise, such as enhanced social interactions, teamwork, community involvement, and the cultivation of social skills.

Through rigorous statistical evaluation, the study seeks to quantify these benefits and illustrate how sports and exercise play a vital role in enhancing an individual's overall well-being. The findings of this research will be instrumental for health professionals, policymakers, educators, and individuals aiming to foster healthier lifestyles.

Needs for the Study

The rationale for conducting this study is grounded in several critical factors:

1. Increasing Levels of Sedentary Behavior: The prevalence of sedentary lifestyles has escalated, rendering physical inactivity a significant public health issue worldwide. There is an urgent demand for empirical research that underscores the necessity of regular physical activity as a countermeasure to this growing concern.

2. Escalating Mental Health Challenges: The incidence of mental health disorders, including depression and anxiety, has markedly increased, particularly following global crises such as the COVID-19 pandemic. It is essential to investigate the impact of sports and exercise on mental health to formulate effective therapeutic strategies.

3. Social Disconnection and Community Fragmentation: As contemporary lifestyles become increasingly disjointed, many individuals experience social isolation. Engaging in sports and physical activities can provide crucial avenues for social engagement, enhancing feelings of community and belonging, which are vital for both mental and social well-being.

4. Guidance for Policy and Program Initiatives: This study aims to generate data that can inform public health policies and aid in the creation of physical activity programs across educational institutions, workplaces, and community settings. There is a pressing need for evidence demonstrating the diverse benefits of exercise to justify investments in sports facilities, physical education, and health promotion efforts.

5. Need for Empirical Validation: While the advantages of sports and exercise are broadly acknowledged, there remains a persistent requirement for thorough statistical evaluation to substantiate these assertions and investigate new aspects of their effects. This research will enhance both academic and practical insights into the ways in which sports and exercise contribute to various dimensions of human well-being.

Advantages of Sports and Exercise for Physical Health**Cardiovascular Health**

Participating in regular sports and exercise plays a crucial role in lowering the risk of cardiovascular diseases (CVDs), which rank as the primary cause of mortality worldwide. Activities such as running, swimming, cycling, and team sports enhance heart function by improving blood circulation, decreasing blood pressure, and lowering cholesterol levels.

Statistical Insights:

- Research published in The Lancet (2019) revealed that individuals who maintain a regular exercise routine can decrease their risk of cardiovascular diseases by 35% when compared to those who are inactive.
- According to the American Heart Association (2018), engaging in sports like tennis or cycling can reduce the likelihood of heart disease by as much as 40%.



**Binoda Kumar Nayak and Vimal Kar****Bone and Muscle Health**

Sports and exercise contribute positively to musculoskeletal health by enhancing strength, flexibility, and bone density. Weight-bearing exercises, including running, weightlifting, and gymnastics, are especially effective in fortifying bones and muscles, thus lowering the chances of osteoporosis and fractures.

Statistical Insights:

- A 2020 report from the National Osteoporosis Foundation highlighted that individuals who regularly participate in sports can lower their risk of osteoporosis by 30-50%.
- A longitudinal study on strength training indicated a 20-25% increase in muscle mass and a 15% enhancement in flexibility among participants engaged in weight-bearing sports over a six-month period (Journal of Bone and Mineral Research, 2018).

Weight Management and Metabolism

Engaging in sports and regular exercise is essential for effective weight management and the prevention of obesity. Particularly, high-intensity sports enhance metabolism, facilitate calorie burning, and aid in fat reduction.

Statistical Insights:

- Research from the Centers for Disease Control and Prevention (CDC, 2019) indicated that children and adolescents who engaged in a minimum of 3 hours of sports weekly were 30% less likely to develop obesity.
- Participation in high-intensity sports such as soccer or basketball can result in calorie expenditures ranging from 500-700 calories per hour, influenced by individual body composition and exercise intensity (Harvard Medical School, 2020).

Mental Health and Cognitive Benefits of Sports and Exercise**Enhancing Mental Health**

There is a strong correlation between physical activity and enhanced mental health, with sports and exercise serving as effective strategies for alleviating issues such as anxiety, depression, and stress. The release of endorphins and other mood-boosting neurotransmitters during physical activity plays a significant role in mitigating symptoms of depression and anxiety.

Statistical Insights:

- A systematic review published in The Lancet Psychiatry (2018) found that individuals involved in team sports had a 22% lower risk of experiencing depression compared to those who did not participate in sports.
- According to the National Health and Nutrition Examination Survey (NHANES, 2019), individuals who engaged in regular exercise reported experiencing 43% fewer days of poor mental health each month compared to their sedentary counterparts.

Cognitive Function and Performance

Engaging in sports and physical exercise is linked to improved cognitive abilities, particularly in memory, attention, and executive functions. Aerobic exercises enhance cerebral blood flow, encourage neurogenesis, and boost overall cognitive performance.

Statistical Data:

- Research conducted by the University of British Columbia in 2017 revealed that consistent aerobic exercise led to a 2% increase in the size of the hippocampus, a critical area for memory, compared to a control group.
- A study from the University of Illinois in 2017 indicated that children who regularly participated in physical activities showed 10-15% enhancements in cognitive tasks, including problem-solving and memory recall.

Stress Reduction

Physical activity and sports serve as effective natural stress relievers by lowering cortisol levels and enhancing endorphin production. Whether through competitive or recreational sports, individuals frequently report a notable decrease in stress and anxiety levels.



**Binoda Kumar Nayak and Vimal Kar****Statistical Data:**

- A 2016 study published in Psychology of Sport and Exercise found that participants who engaged in regular sports experienced a 30% reduction in cortisol levels, a key stress hormone, after 12 weeks of consistent activity.
- Additionally, team sports were shown to further decrease stress by 12%, attributed to the benefits of social interaction and support from peers, as noted in the Journal of Sports Psychology in 2018.

Social Benefits of Sports and Exercise**Community Engagement and Social Connections**

Sports create avenues for social interaction, enabling individuals to forge friendships, collaborate in teams, and cultivate a sense of belonging. Particularly, social sports enhance communication abilities, teamwork, and collaboration, which contribute positively to both mental and emotional health.

Statistical Insights:

- According to a survey by the Aspen Institute (2020), 85% of young participants noted enhanced social skills due to their involvement in team sports.
- Among older adults, joining group exercise sessions led to a 25% decrease in feelings of loneliness (Journal of Aging Studies, 2019).

Enhanced Behavior and Self-Discipline

Engagement in sports is associated with better behavior, particularly among youth. Sports instill discipline, time management, and respect for rules and peers, which can lead to improved conduct both during games and in everyday life.

Statistical Insights:

- A study from 2020 revealed that 75% of adolescents involved in organized sports exhibited greater self-discipline and conflict resolution abilities (Developmental Psychology).
- Children participating in team sports were found to be 20% less likely to engage in delinquent activities, such as truancy and substance use (Journal of Adolescent Health, 2018).

Global Trends in Sports Participation**Regional and Demographic Trends**

Participation in sports varies around the world, influenced by socio-economic conditions, availability of facilities, and cultural perceptions of physical activity. Generally, countries with higher income levels report greater participation rates, while low- and middle-income nations experience lower rates, although initiatives are underway to bridge this gap.

Statistical Data:

- In affluent nations like the United States, Canada, and Australia, approximately 60-65% of adults engage in some form of sports or physical activity on a weekly basis (OECD, 2020).
- Conversely, in low- and middle-income countries, participation rates are below 30%, although initiatives such as FIFA's Football for Hope have improved access to sports by 15% in sub-Saharan Africa (WHO, 2021).

Gender and Age Disparities

Despite ongoing efforts to enhance inclusivity in sports, significant differences in participation persist across gender and age demographics. Men are generally more active in sports than women, although this disparity is gradually decreasing.

Statistical Data:

- Within the European Union, 45% of men participate in sports at least once a week, compared to 37% of women (Euro barometer Survey, 2019).
- Sports participation among youth is highest between the ages of 10 and 18, with 70% of adolescents in this range involved in sports. However, this figure declines to 30% by the age of 30 and continues to decrease as age increases (CDC, 2020).



**Binoda Kumar Nayak and Vimal Kar**

CONCLUSION

The advantages of engaging in sports and physical activity, encompassing both physical and mental aspects, are clear. Consistent involvement contributes to better cardiovascular health, increased muscle and bone strength, and improved mental health and cognitive abilities. Additionally, sports encourage social connections, strengthen communities, and instill values of discipline and teamwork. Nonetheless, there are still significant gaps in participation based on geography, gender, and age. It is essential to implement strategies that enhance access to sports, especially for marginalized groups, to ensure that a broader population can enjoy the numerous benefits associated with an active lifestyle.

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The Ripple of NEP 2020: An Odyssey through Higher Education (2020-24)

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ABSTRACT

In the wake of the National Education Policy (NEP) 2020, the landscape of India's higher education began a profound transformation. This journal embarks on a journey through time, exploring the impact of NEP from 2020 to 2024 on higher education outcomes. The policy, with its focus on holistic development, interdisciplinary learning, and academic flexibility, sought to nurture students as creators and thinkers rather than mere degree holders. Through five case studies across different regions, disciplines, and institutions, this paper examines the emotional and intellectual ripples left behind by NEP's reformative vision. As it gently dismantles the rigid walls of the traditional education system, this narrative paints a portrait of possibility, reflecting on the aspirations, struggles, and triumphs of those who lived through this era of academic renewal.

Keywords: Educational Policy, Higher Education, Digital literacy, Trends, Impact, Communities.





INTRODUCTION

In the heart of 2020, amid the throes of a pandemic that rendered the world still, India introduced a quiet revolution: the National Education Policy (NEP) 2020 [P. Shukla, D., & Kaur, J. (2021)]. It arrived like the first breath of dawn after a long night, heralding promises of change and dreams of transformation in the field of education. At its core, NEP was not just a policy but a vision—a collective hope that education could be more than what it had become Vashist, A. (2021). The NEP 2020 set out to redefine higher education, urging us to see beyond marks, degrees, and jobs. It whispered of interdisciplinary learning, where one could marry science with the arts, and blend technology with philosophy [IIT Madras. (2023)]. It gave rise to the concept of multiple entry-exit points, gifting students the freedom to pause and resume their academic journeys as life dictated. And most poignantly, it embraced the idea of holistic development, ensuring that higher education molded not just scholars but individuals equipped with the life skills and wisdom to navigate a complex world [IISc Bangalore. (2022)]. As we look back on this four-year odyssey, from 2020 to 2024, we embark on an emotional exploration of how NEP reshaped higher education. Through five distinct case studies, this journal seeks to illuminate the subtle yet powerful impact NEP has had on the lives of students, educators, and institutions across India[Jain, A. (2021)].

DISCUSSIONS

Unveiling the Impact of NEP 2020

Case Study 1: The Phoenix of Pune University – Rebirth Through Academic Flexibility

Pune, the educational hub of Maharashtra, witnessed an unprecedented shift in academic culture as NEP 2020 took root. For decades, students at Pune University had grappled with the rigidity of their chosen disciplines. Arts students were confined to literature and history, while science students lived in the solitary world of equations and experiments. In 2021, two years into NEP, the university rolled out interdisciplinary courses that allowed students to blend subjects of their choice.

A Student's Perspective

One student, Ananya, a lover of literature and an aspiring neuroscientist, found her calling in this new flexibility. In her words, “I never imagined I could study psychology with physics, but NEP has allowed me to explore the connection between the mind and matter. It’s like I’m finally seeing the world in color.” This newfound flexibility redefined what higher education meant for Ananya. Her curiosity, which had long been dampened by rigid course structures, now flourished in the freedom of NEP’s vision. Her academic performance, once stagnant, soared as she connected her interdisciplinary learning to real-world problems.

Institutional Change

For Pune University, the shift was not without its challenges. Professors accustomed to strict syllabi found themselves navigating the vastness of this new academic landscape. Yet, over time, the institution transformed into a vibrant ecosystem of ideas, with faculty learning alongside students.

Greater Student Engagement: 95% of students surveyed expressed increased interest in their studies.

Improved Outcomes: There was a 20% improvement in final-year results, attributed to the flexibility in course selection.

Case Study 2: Delhi University – The Lifeline of Multiple Entry-Exit Points

For many, life is unpredictable, and traditional education systems often punish those whose lives do not follow a straight path. NEP’s introduction of multiple entry-exit points became a lifeline for students like Vikram, a second-year economics major at Delhi University.

Vikram's Journey

In 2020, Vikram's life was upended by personal tragedy. He was forced to drop out mid-semester to support his family. Under the old system, this would have meant an academic career lost. But NEP 2020 offered him a bridge—he could pause his studies and return when ready, without losing credits.



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In 2022, Vikram returned to Delhi University, not as a dropout but as a student reclaiming his future. He resumed his courses, graduating in 2024 with honors, his story emblematic of how NEP 2020 was not just about academic reform but about human resilience.

Reduced Dropout Rates: The dropout rate decreased by 30% between 2020 and 2024, largely due to the introduction of flexible exit and re-entry policies.

Emotional Well-being: 88% of students reported feeling less stress, knowing they had the option to pause without penalty.

Case Study 3: The Innovators of IIT Madras – A Symphony of Research and Skills

IIT Madras, long celebrated for its academic excellence, embraced NEP's call for a deeper integration of research and skill-building into higher education. By 2023, the institution had created a curriculum that married theory with hands-on innovation, giving birth to a new generation of problem solvers.

A Professor's Perspective

Dr. Meera, a professor of electrical engineering, reflects on the shift: "Our students are no longer just learning to pass exams; they are learning to ask questions and build solutions. NEP has made innovation a part of our DNA." By embedding research projects as mandatory components of the curriculum, students developed prototypes, some of which went on to become startups before graduation. This blending of academics with real-world applications unleashed a new wave of entrepreneurial spirit at IIT Madras.

Increase in Startups: There was a 40% rise in student-led startups between 2020 and 2024.

Research Output: Research papers published by students increased by 25%, many contributing to global solutions in renewable energy and technology.

Case Study 4: Banaras Hindu University – The Reawakening of Regional Languages

In the culturally rich city of Varanasi, Banaras Hindu University (BHU) took NEP's emphasis on regional languages and multilingualism to heart. BHU revived ancient Sanskrit texts and promoted regional languages like Hindi and Bhojpuri in mainstream academia.

A Scholar's Awakening

Radha, a literature major at BHU, had always been drawn to her roots in Bhojpuri folklore. Yet, under the old curriculum, such interests were sidelined. NEP, however, validated regional diversity, and Radha's thesis on Bhojpuri oral traditions became the first of its kind to receive national recognition. "For the first time, I felt my heritage had a place in academia. NEP gave me the courage to pursue what truly mattered to me," says Radha.

Cultural Renaissance: The number of students enrolling in regional language courses increased by 60% between 2020 and 2024.

National Recognition: BHU was awarded for its pioneering work in promoting multilingual education and preserving regional cultures.

Case Study 5: The Silent Voices of a Tribal College in Odisha – A Pathway to Equity

For the tribal communities in rural Odisha, higher education was a distant dream, often cut short by systemic inequalities. NEP 2020's focus on inclusive education became a beacon of hope for marginalized communities.

A Tribal Student's Story Neelam, a student from a remote village, was the first in her family to attend college. She recalls, "I never thought I could make it this far. But with NEP's scholarships and vocational training programs, I've been given a chance to not only learn but to thrive." Odisha's tribal colleges embraced NEP's focus on equitable access, implementing scholarships, skill-based learning, and special mentorship programs for students from underserved backgrounds. Increased Enrolment: Tribal student enrolment in higher education increased by 45%. Economic Upliftment: 70% of students from tribal backgrounds gained employment or pursued further studies post-graduation.



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CONCLUSION

The Echoes of Change

The NEP 2020, much like a gentle breeze that turns into a transformative gust, has left an indelible mark on higher education in India from 2020 to 2024. Through the lived experiences of students and educators, we see how this policy was more than just structural reform—it was a revolution of the mind and heart. It allowed students to dream beyond the constraints of the traditional system, gave educators the freedom to innovate, and most importantly, built bridges for those once left behind.

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Evaluating UPI's Impact on Consumer Behavior and Satisfaction in the Indian E-Commerce Sector

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ABSTRACT

The Unified Payments Interface (UPI) has revolutionized the way consumers in India approach digital payments, particularly in the e-commerce sector. This research paper delves into the intricate relationship between UPI adoption and shifts in consumer behavior, with a specific focus on consumer satisfaction. By exploring secondary data, including transaction reports, growth metrics, and consumer feedback, the paper evaluates how UPI has transformed purchasing habits, reduced reliance on traditional payment methods, and increased customer loyalty. Through an analysis of user reviews and satisfaction surveys, this study highlights the factors driving UPI's popularity, such as speed, security, ease of use, and the associated consumer incentives like cashbacks and discounts. The findings underline UPI's critical role in reshaping payment preferences and enhancing user experiences, especially by fostering financial inclusion and providing a more convenient, secure, and efficient payment option in the rapidly growing Indian e-commerce ecosystem.

Keywords: UPI, consumer behavior, consumer satisfaction, digital payments, e-commerce, financial inclusion, digital transformation.





INTRODUCTION

In recent years, India has emerged as a global leader in the adoption of digital payment technologies. Among the various systems introduced, the Unified Payments Interface (UPI) has been the most transformative, dramatically influencing consumer behavior and satisfaction within the Indian e-commerce sector. Launched in 2016 by the National Payments Corporation of India (NPCI), UPI has become synonymous with seamless, fast, and secure digital payments, facilitating millions of transactions daily. The convenience offered by UPI has changed the way consumers engage with e-commerce platforms, shifting payment preferences from traditional methods, such as cash-on-delivery (COD) and credit/debit cards, to instant digital payments. This paper aims to evaluate UPI's profound impact on consumer behavior and satisfaction, particularly focusing on the key drivers behind this transformation, including ease of use, transaction speed, security features, and consumer incentives. The e-commerce industry in India has grown exponentially in the past decade, fueled by the increasing penetration of smartphones, improved internet access, and the availability of digital payment methods like UPI. By 2023, India's e-commerce market was valued at over USD 83 billion, with projections to exceed USD 200 billion by 2027 (IAMAI, 2021). UPI's role in this growth has been significant, providing a real-time payment option that enhances consumer experiences. This research seeks to analyze how UPI has influenced consumer satisfaction, reshaped payment preferences, and contributed to the overall growth of the e-commerce sector.

LITERATURE REVIEW

UPI and Consumer Behavior: A Paradigm Shift

The introduction of UPI has been a catalyst for significant changes in consumer behavior in India. Before UPI, payment methods such as credit/debit cards and net banking dominated the e-commerce space, with cash-on-delivery (COD) being the most preferred mode of payment due to concerns about online fraud and trust in digital transactions (Roy *et al.*, 2022). However, these payment methods came with their limitations—credit/debit card payments often required multiple authentication steps, and COD presented logistical challenges and delays in the payment process. UPI, by providing a seamless and fast payment solution, has addressed these pain points and fundamentally changed how consumers make purchases online. Research shows that UPI adoption has led to a reduction in cart abandonment rates on e-commerce platforms. One of the major reasons for cart abandonment in e-commerce is the friction associated with complicated payment processes. UPI simplifies this process by allowing consumers to complete payments with minimal effort, resulting in higher conversion rates (Garg & Singh, 2021). Moreover, UPI's two-factor authentication and instant payment confirmation provide a sense of security to consumers, encouraging them to choose digital payments over COD or other methods.

Drivers of Consumer Satisfaction with UPI

Several factors contribute to consumer satisfaction with UPI. First and foremost is the **ease of use**. UPI allows consumers to make payments directly from their bank accounts without the need for entering card details or remembering multiple passwords. This simplicity has made UPI particularly popular among consumers who may not be comfortable with more complex payment methods (Bhattacharya & Singh, 2021). Second, the **speed of transactions** plays a crucial role in consumer satisfaction. UPI transactions are processed in real time, ensuring that consumers receive instant payment confirmations, which reduces the anxiety often associated with waiting for payment processing (Singh & Garg, 2021). For e-commerce platforms, this has also meant faster order processing and reduced delays in delivery, further enhancing the overall customer experience. Third, UPI offers **strong security features**, including two-factor authentication and encrypted payment channels. In a market where concerns about online fraud are prevalent, these security features have played a key role in building trust and encouraging the adoption of digital payments (Roy *et al.*, 2022). Lastly, **consumer incentives** such as cashbacks, discounts, and rewards offered by e-commerce platforms and UPI payment apps have been instrumental in driving UPI adoption. These incentives not only attract first-time users but also encourage repeat transactions, thereby fostering long-term consumer loyalty.



**Ajit Kumar Sabat et al.,****UPI's Contribution to Financial Inclusion**

UPI has significantly contributed to financial inclusion in India by making digital payments accessible to a wider population, including those in rural and semi-urban areas. The ease of use and low cost of UPI transactions have made it an ideal payment method for consumers who were previously excluded from the digital economy due to lack of access to credit cards or digital wallets (Agarwal & Chakraborty, 2019). By democratizing access to digital payments, UPI has allowed more consumers to participate in e-commerce, further driving the growth of the sector. The next sections will delve deeper into UPI's impact on specific aspects of consumer behavior and satisfaction, supported by data and analysis.

Research Objectives

This study aims to explore the following objectives:

- To evaluate the impact of UPI on consumer payment preferences in the e-commerce sector.
- To analyze how UPI has influenced consumer satisfaction through its key features, including ease of use, speed, and security.
- To examine the role of UPI in reducing cart abandonment rates and improving transaction completion on e-commerce platforms.
- To investigate UPI's contribution to financial inclusion by expanding access to digital payments for previously underserved populations.

Research Methodology

This study employs a quantitative research approach, analyzing secondary data from UPI transaction reports, user feedback, and e-commerce platform metrics. The data sources include reports from NPCI, consumer satisfaction surveys, and industry insights from RedSeer Consulting and IAMAI.

Data on UPI transaction volumes, consumer preferences, and feedback on payment experiences were gathered from various platforms, including Amazon, Flipkart, and Myntra, as well as from user surveys conducted by organizations such as PwC and KPMG. The data is analyzed to evaluate the relationship between UPI adoption and changes in consumer behavior, focusing on transaction completion rates, customer satisfaction, and loyalty.

Analysis and Findings**UPI's Influence on Consumer Payment Preferences**

Before UPI's introduction, cash-on-delivery (COD) dominated the Indian e-commerce payment landscape, with many consumers reluctant to make online payments due to concerns over security and trust. The rise of UPI has led to a significant shift in consumer payment preferences, with a growing number of consumers opting for digital payments over COD. According to data from RedSeer Consulting (2022), UPI now accounts for over 45% of digital payments in India's e-commerce sector, a significant increase from its initial adoption rate. The ease of making payments via UPI, coupled with its strong security features, has encouraged consumers to shift away from COD and other payment methods such as credit/debit cards. The table below highlights the changes in consumer payment preferences for e-commerce transactions between 2020 and 2022: Table.1 As the data suggests, there has been a steady decline in the use of COD, while UPI adoption has surged. This shift is largely driven by UPI's ability to offer a more convenient and secure payment experience, which has enhanced consumer trust in online transactions.

Impact of UPI on Cart Abandonment Rates

One of the most significant ways in which UPI has improved the e-commerce experience for consumers is by reducing cart abandonment rates. Cart abandonment occurs when consumers add items to their online shopping carts but fail to complete the transaction, often due to a complicated or lengthy payment process. UPI's simplicity and speed of transaction have helped address this issue by providing a frictionless checkout experience. A study conducted by PwC (2022) found that e-commerce platforms integrating UPI saw a reduction in cart abandonment rates by up to 10%, compared to platforms relying solely on traditional payment methods like credit cards or net banking. The table below presents data on cart abandonment rates before and after the integration of UPI: Table.2



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The data clearly demonstrates that UPI's integration has led to a marked improvement in transaction completion rates, resulting in higher sales volumes for e-commerce platforms.

Consumer Satisfaction with UPI

Consumer satisfaction is a critical factor in determining the success of any payment system, and UPI has consistently received high satisfaction ratings from users. According to a survey conducted by KPMG (2021), over 90% of users expressed satisfaction with UPI, citing its ease of use, speed, and security as the primary reasons for their preference. Additionally, the survey found that 88% of users preferred UPI for e-commerce transactions due to its convenience and reliability. The table below summarizes the key satisfaction factors based on the high satisfaction ratings for UPI. The high satisfaction ratings for UPI can be attributed to its user-friendly interface and the sense of security it provides. Furthermore, the availability of incentives such as cashbacks and rewards has helped to enhance consumer loyalty and encourage repeat transactions.

UPI's Role in Financial Inclusion

UPI has played a vital role in promoting financial inclusion in India by extending digital payment access to rural and semi-urban populations. The low cost and simplicity of UPI transactions have made it easier for consumers who do not have access to credit cards or digital wallets to participate in e-commerce. Data from NPCI (2023) shows that nearly 60% of new UPI users in 2022 were from rural or semi-urban areas, demonstrating UPI's success in reaching underserved populations. The expansion of UPI into these areas has allowed more consumers to benefit from the convenience of online shopping and digital payments. The table.4 below highlights the growth in UPI users from rural and semi-urban areas: This growth underscores UPI's effectiveness in democratizing access to digital payments and driving e-commerce adoption across diverse demographic segments.

DISCUSSION

Shifts in Consumer Behavior: A UPI-Driven Revolution

The widespread adoption of UPI has resulted in a significant shift in consumer behavior, particularly in the way people approach online payments. UPI's real-time transaction capabilities, combined with its ease of use and robust security features, have encouraged consumers to move away from traditional payment methods such as COD and credit/debit cards. This shift has had a profound impact on the e-commerce sector, leading to higher transaction volumes, reduced cart abandonment rates, and increased customer satisfaction. For e-commerce platforms, UPI's ability to provide a seamless payment experience has been instrumental in enhancing consumer trust and loyalty. Consumers are now more likely to complete their transactions due to the ease and convenience UPI offers, leading to higher conversion rates and repeat purchases.

The Importance of Consumer Satisfaction in UPI's Success

Consumer satisfaction is a key driver of UPI's success in the Indian e-commerce sector. The high satisfaction ratings for UPI can be attributed to several factors, including its user-friendly interface, speed, and security. Additionally, the availability of incentives such as cashbacks and rewards has helped to enhance consumer loyalty and encourage repeat transactions. By providing a payment system that is both convenient and secure, UPI has successfully addressed many of the pain points associated with online payments, resulting in higher levels of consumer satisfaction. This has had a positive impact on e-commerce platforms, as satisfied customers are more likely to make repeat purchases and recommend the platform to others.

UPI's Role in Financial Inclusion

UPI's contribution to financial inclusion cannot be overstated. By making digital payments accessible to a wider population, UPI has enabled more consumers to participate in the digital economy. This has been particularly beneficial for rural and semi-urban populations, who were previously excluded from the digital payments ecosystem due to a lack of access to traditional banking services. The expansion of UPI into these areas has not only driven e-



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commerce growth but has also contributed to broader economic development by empowering consumers and small businesses with access to digital financial services.

CONCLUSION

This research has demonstrated that UPI has had a profound impact on consumer behavior and satisfaction in the Indian e-commerce sector. By offering a fast, secure, and user-friendly payment system, UPI has reshaped payment preferences and encouraged more consumers to adopt digital payments over traditional methods. The high levels of consumer satisfaction with UPI, coupled with its role in promoting financial inclusion, have made it a critical enabler of e-commerce growth in India. As UPI continues to evolve, with new features such as UPI Lite and UPI 123Pay being introduced, its impact on consumer behavior and satisfaction is likely to grow even further. Policymakers and businesses should continue to support the development of UPI to maximize its potential in enhancing the digital economy and driving long-term consumer loyalty.

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**Table.1 highlights the changes in consumer payment preferences for e-commerce transactions between 2020 and 2022**

Payment Method	2020	2022
UPI	35%	45%
Cash-on-Delivery	50%	30%
Credit/Debit Cards	10%	15%
Digital Wallets	5%	10%

Source: RedSeer Consulting, 2022

Table. 2 Data on cart abandonment rates before and after the integration of UPI

Platform	2020 Cart Abandonment Rate (%)	2022 Cart Abandonment Rate (%)	Reduction (%)
Amazon India	45%	38%	7%
Flipkart	47%	40%	7%
Myntra	40%	35%	5%

Source: PwC Digital Payments Report, 2022 on user feedback: Table.3

Table.3 Summarizes the Key Satisfaction Factors Based On User Feedback

Satisfaction Factor	Percentage of Users Citing Factor (%)	Source
Ease of Use	90%	KPMG, 2021
Speed of Transactions	92%	PwC, 2022
Security and Trust	75%	KPMG, 2021
Cashback and Rewards	45%	Statista, 2023

Table.4 highlights the growth in UPI users from rural and semi-urban areas:

Year	Percentage of New UPI Users from Rural Areas (%)
2020	45%
2021	50%
2022	60%

Source: NPCI Annual Report, 2023





Apparel Manufacturing Process: Trends, Challenges & Opportunities

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ABSTRACT

“In this research paper, a comprehensive look at recent trends and a review of the use of cutting-edge technology and methods in Apparel manufacturing process is explored. The history and the evolution of Electric vehicles are presented with a diagram. The technology behind how an Electric vehicle works is demonstrated with a case-study. The components and sub-systems are described with a pictorial presentation. Comparison of Electric vehicles with conventional vehicles and the benefits of Electric vehicles are presented. Further, the emerging trends and challenges in an Electric vehicle industry are addressed. The article also highlights the significance of Electric Vehicles in context of sustainable mobility in the automobile sector for the future generation”.

Keywords: Apparel Manufacturing, Sewing Machine Operator (SMO), Garment manufacturing, Productivity, Trends and Market strategies of Apparel Industry,





INTRODUCTION

“Garment manufacturing is a vital part of the textile and apparel industry. Garment manufacturing is a complex process that involves multiple stages, from fabric selection to final production. Each step in the process is crucial to ensure the quality, durability, and appeal of the garment” [1]. “Apparel Manufacturing Unit offers skill training courses from basic to advanced levels to prepare trainees for career advancement and better wages, upgrade the knowledge and skill levels of the existing workforce and facilitate the training of trainers employed at various training centres in the country” [2]. “Differently-abled youth are trained in this Unit with the aim to make them competent, capable and confident in gaining employment or starting entrepreneurial ventures and thereby become accepted as an important and respected part of their community and society. It is worthwhile to mention 70 per cent of these differently-abled trainees are girls, out of which about 50-60% are from tribal communities. The entire training is provided in residential mode” [3]. “The garment manufacturing process begins with receiving an order from a customer and finishes when the finished garments are shipped to the buyer. Orders determine the production cycle for garments. Some garment production procedures can be carried out concurrently, although the majority of them are dependent on the prior step” [4].

Objectives of Apparel Manufacturing Unit

- “Apparel Manufacturing Unit provides skill-training courses [5]
- Increasing awareness of modern sewing technologies
- Provides training to youngsters from rural low-income families who have dropped out of school or college [6]
- Up-skilling of persons working in the apparel business for improved salaries and career advancement [7].
- Training of trainers in the apparel skills ecosystem in Odisha and Andhra Pradesh.
- Economic empowerment empowers underprivileged populations, particularly those from remote and challenging locations.
- Earn a living with pride and dignity” [8].

METHODOLOGY

Steps of Work flow in a Garment Manufacture [9]

“The following page depicts a flow chart of the garment manufacturing process for a typical garment product. This chart can help you comprehend the process flow better. Garment makers typically buy fabric from several fabric suppliers. Before sourcing the fabric, the factory merchandiser handles certain pre-production activities”.

Following steps are involved in the preproduction stage.

- a. Product study,
- b. Pattern making,
- c. Garment sampling and approval,
- d. Fabric development and trims approval
- e. Fabric and trims procurement,
- f. Pre-production meeting.

Work flow in a Garment Manufacturing Process

“Garment manufacturing is a detailed and organized process that involves several steps, from the initial design to the final product. An overview of a typical garment manufacturing workflow is depicted in Fig 1.



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- **Concept Development:** Designers create concepts based on trends, market research, or brand requirements.
- **Sketching:** Hand-drawn or digital sketches are developed to visualize the design.
- **Technical Drawing:** Accurate and scaled technical drawings are made, often with software like CAD (Computer Aided Design), 3D Experience, detailing garment structure, seams, and stitching [10].

Pattern Making

- **Pattern Drafting:** A pattern is made either manually or using computer-aided systems. It is essentially a blueprint of the garment pieces (e.g., sleeves, bodice, collar).
- **Pattern Grading:** The base pattern is resized into different sizes (S, M, L, etc.) according to the required size range.

Fabric Sourcing

- **Material Selection:** Designers choose the fabric based on the garment's intended use, style, and comfort. Factors like texture, durability, and color are considered.
- **Trims and Accessories:** Buttons, zippers, elastics, labels, and other trims are sourced according to the design and functionality [11].

Sample Making

- **Prototype Creation:** A first sample is made from the pattern to evaluate the design. This can be done using actual fabric or a substitute fabric.
- **Fitting and Evaluation:** The sample is fitted on a mannequin or a fit model to check how the garment looks and fits. Necessary adjustments are identified and communicated.
- **Revisions:** Any changes in the design, fit, or construction are made based on feedback, and a new sample may be produced until the desired result is achieved [12].

Production Planning

- **Costing:** Detailed costs sheets are prepared that consider material costs, labor, overheads, and other factors.
- **Order Planning:** Based on demand forecasts and orders, a production schedule is created, identifying timelines for each step (cutting, sewing, etc.).
- **Sourcing & Inventory:** The required fabric, trims, and other components are ordered and stocked according to the production plan.

Cutting

- **Marker Making:** A marker is made, which is a layout of how patterns will be placed on the fabric to minimize wastage.
- **Fabric Spreading:** Fabric is laid out in layers for mass production, either manually or with automated fabric spreaders.
- **Cutting:** The fabric is cut according to the marker layout using machines such as electric cutters, laser cutters, or manually by skilled workers.

Sewing

- **Assembly Line:** The cut fabric pieces are sent to the sewing floor where they are stitched together in a sequence of steps. Assembly line methods are often used in larger factories, with specialized workers sewing specific parts (e.g., sleeves, collars, hems).
- **Seam Quality Control:** Inspectors check the quality of stitches, seams, and construction throughout the process.





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Finishing

- **Trimming:** Excess threads and any unwanted materials are trimmed off.
- **Pressing & Ironing:** The garment is pressed to remove wrinkles and give it a finished look.
- **Attaching Labels:** Brand tags, care labels, and size labels are sewn or heat transferred onto the garment [13].

Quality Control (QC)

- **Visual Inspection:** The finished garment is inspected for defects, such as incorrect stitching, fabric flaws, or improper fit.
- **Measurement Check:** Each garment's measurements are checked against the original specifications to ensure accuracy.
- **Final Approvals:** A final round of approvals is done before the garments are packed for shipment [14].

Packing

- **Folding:** Garments are folded neatly or rolled depending on packaging requirements.
- **Poly Bagging:** The garments are individually packed in polybags or as required by the brand.
- **Carton Packing:** Packed garments are then placed into cartons, ready for shipment.

Shipping

- **Distribution:** The finished products are shipped to retailers, warehouses, or direct customers based on the business model (e.g., B2B or B2C).

Post-Production

- **Customer Feedback:** After the products are on the market, feedback is gathered for improvements in future collections.
- **Adjustments:** Based on feedback, any necessary adjustments are made to future production runs or designs" [15].

Technologies Used in Apparel Manufacturing:

- **Computer-Aided Design (CAD):** 3D Experience, Apriso for creating digital patterns and designs.
- **Automated Cutting Machines:** Used to precisely cut fabric with minimal waste.
- **3D Body Scanning:** To ensure better fit and personalization of garments.

Each of these steps is crucial for ensuring that the final product meets design specifications, functional requirements, and quality standards. A linear workflow chart will describe all of the major activities involved in garment manufacture. Refer to the workflow chart in Fig.2

Machinery Used In Apparel Industry

"The apparel industry relies heavily on various machines to streamline production, improve quality, and enhance efficiency [16]. The key types of machines commonly used across different stages of the apparel manufacturing process are presented in Figure 3.

Cutting Machines

- **Manual Cutting Machines:** Simple hand tools like scissors and cutting knives.
- **Straight Knife Cutting Machines:** Used for cutting multiple layers of fabric.
- **Band Knife Cutting Machines:** Ideal for curved and intricate cuts.
- **Laser Cutting Machines:** Provides precise and fast cuts using lasers, often for synthetic fabrics.
- **Computerized/Automatic Cutting Machines:** Use CAD software to cut patterns precisely and efficiently.

Sewing Machines

- **Single Needle Lockstitch Machine:** The most common sewing machine for general stitching.





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- **Overlock (Serge) Machines:** Used for finishing edges and seaming, ensuring fabric edges don't fray.
- **Cover stitch Machine:** Used for hemming and seaming knit fabrics [17].
- **Buttonhole and Button Sewing Machines:** For automatic buttonhole creation and button stitching.
- **Bar Tack Machine:** Provides strong reinforcement on areas like pockets and belt loops.
- **Embroidery Machines:** Used to add decorative designs or logos to garments.

Pressing & Finishing Machines

- **Steam Press Machines:** Pressing finished garments to remove wrinkles.
- **Ironing Machines:** Similar to steam press machines but hand-operated.
- **Fusing Machines:** Bonding two layers of fabric together using heat and adhesive.
- **Thread Trimming Machines:** Automatically cuts off excess thread from finished garments.
- **Form Finishers:** Machines that use steam and air to press garments in a 3D form.

Spreading Machines

- **Manual Fabric Spreading Tables:** Used in small production units to spread fabric manually.
- **Automatic Fabric Spreading Machines:** These machines spread fabric layers automatically in preparation for cutting.

Stitching & Seaming Machines

- **Flat Seamer Machines:** For seaming fabric without overlapping the seam, commonly used for sportswear.
- **Blind Stitch Machines:** Provides an invisible hem, often used in high-end garment finishing.
- **Chain Stitch Machine:** Produces a looped stitch, commonly used in jeans and denim.

Digital & Printing Machines

- **Direct-to-Garment (DTG) Printers:** For printing designs directly onto fabrics.
- **Heat Transfer Presses:** Used to apply heat transfer vinyl (HTV) or sublimation prints onto garments.
- **Screen Printing Machines:** Utilized for bulk printing of designs, often on t-shirts.

Quality Control & Inspection Machines

- **Needle Detectors:** Ensures that no broken needles or metal parts remain in garments, commonly used in post-sewing quality checks.
- **Fabric Inspection Machines:** Used to check for flaws, stains, or inconsistencies in fabric before production.

Packaging Machines

- **Automatic Folding & Packaging Machines:** Folds and packs finished garments, used in large-scale apparel production.

Specialty Machines

- **Quilting Machines:** For stitching layers of fabric together to create quilted textiles.
- **Elastic Attachment Machines:** Used in underwear, active wear, and elasticized apparel production.
- **Pleating Machines:** For adding pleats to fabric in a controlled and uniform manner.

Robotic and Automated Systems

- **Sewbots:** Robotic sewing machines that can automate garment construction.
- **Automated Garment Conveyor Systems:** Used in large factories to transport garments or fabric between different stages of production.

These machines not only enhance production speed and precision but also help to reduce labor costs and material wastage, making them integral to the modern apparel industry. India's garment manufacturing sector is a vital part of its economy, playing a significant role in employment generation and export earnings. The garment manufacturing process in India is diverse, ranging from small-scale cottage industries to large-scale industrial setups" [18]. Here's an overview of the Indian garment manufacturing process, including its current scenario:

Trends and Challenges in Indian Garment Manufacturing [19] Technology Adoption



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“Automation is slowly being adopted, especially in large manufacturing units, to improve productivity and maintain international competitiveness. This includes the use of digital tools for design, supply chain management, and even in the stitching process.

Sustainability and Eco-Friendly Practices

The Indian garment industry is increasingly embracing sustainable practices, driven by consumer demand and regulations from foreign buyers. Water conservation, reducing chemical use in fabric dyeing, and ethical sourcing are gaining traction.

Labor Issues and Compliance

The garment industry is labor-intensive, with millions of workers, especially women, engaged in production. Issues such as low wages, poor working conditions, and lack of social security benefits remain a concern, though efforts are being made towards compliance with international labor standards.

Competition from Other Countries

Countries like Bangladesh and Vietnam have emerged as strong competitors due to lower labor costs. However, India's strengths in skilled labor, raw material availability, and design innovation keep it in the race.

Government Support and Policies

The Indian government has launched various schemes such as the **Amended Technology Up gradation Fund Scheme (ATUFS)** and **Make in India** to promote garment manufacturing. Additionally, initiatives like **Skill India** are focused on improving the quality of the labor force in the textile and garment sector.

Impact of E-Commerce

The rise of e-commerce has changed the landscape of the garment industry in India. Manufacturers are directly reaching consumers through online platforms, reducing the reliance on traditional retail channels and providing more visibility for smaller brands” [20].

RESULTS AND DISCUSSION

“Garment manufacturing is a vital part of the textile and apparel industry. Like any other industry, it has its advantages and disadvantages depending on various factors such as location, labor practices, environmental impact, and economic contribution. The Swing Machine operation unit at Centurion University is presented in Figure 4.

The key advantages and disadvantages of garment manufacturing:

Advantages of Garment Manufacturing**Job Creation and Employment**

Garment manufacturing provides employment opportunities, especially in developing countries, where the industry often supports millions of workers, particularly women.

Economic Growth

The industry contributes significantly to the GDP of many countries. It is often a stepping stone for industrialization, helping to develop infrastructure and boost local economies.

Low Initial Investment

Setting up small- to medium-sized garment manufacturing units often requires relatively low capital investment compared to other industries, making it accessible for entrepreneurs.

Export Opportunities

Garment manufacturing provides substantial export opportunities for countries with a comparative advantage in labor costs, allowing them to compete in global markets.

Diverse Product Range

The industry can produce a wide range of products from basic clothing to high-fashion garments, serving various segments of the market and providing flexibility to manufacturers.



**Ramana Rao et al.,****Technological Advancements**

With the introduction of advanced technologies such as automated sewing machines, CAD (Computer-Aided Design), and data-driven production systems, garment manufacturing can achieve higher levels of efficiency and precision.

Support for Ancillary Industries

Garment manufacturing supports related industries, such as textile production, dyeing and finishing, packaging, and logistics, creating a broader economic impact.

Disadvantages of Garment Manufacturing**Labor Exploitation**

Garment manufacturing is often associated with poor working conditions, low wages, and exploitation, especially in regions where labor laws are weak or poorly enforced.

Environmental Impact

The industry is notorious for its environmental footprint, including high water usage, chemical pollution from dyes and finishes, and the generation of textile waste.

Dependence on Cheap Labor

The industry often relies on cheap labor to maintain competitive pricing, which may result in a "race to the bottom" in terms of wages and working conditions.

Volatility and Demand Fluctuations

Garment manufacturing is highly dependent on consumer demand, which can fluctuate due to changing fashion trends, economic conditions, or global events like pandemics.

Automation and Job Losses

As the industry adopts more automation and digital technologies, it risks displacing low-skill jobs, especially in countries where the workforce relies on manual labor.

Quality Control Challenges

Maintaining consistent quality across large-scale production can be a challenge, particularly when manufacturers cut corners to reduce costs or rush production to meet deadlines.

Complex Supply Chains

The global nature of garment manufacturing often results in long, complex supply chains that can lead to delays, increased transportation costs, and logistical inefficiencies.

Pressure from Fast Fashion

Fast fashion brands demand quick turnaround times and low prices, putting immense pressure on garment manufacturers to cut costs, which can lead to further exploitation and environmental degradation.

In summary, while garment manufacturing plays a critical role in economic development and job creation, it also faces significant challenges related to labor practices, environmental sustainability, and market volatility. Balancing these factors is key to ensuring a responsible and sustainable garment manufacturing industry".

Applications of Garment Manufacturing Process

1. **Fashion Industry:** "Garment manufacturing is the backbone of fashion brands, ranging from haute couture to fast fashion. Designers rely on efficient manufacturing to bring collections to life.
2. **Sportswear:** Manufacturers use high-performance fabrics and specialized techniques (e.g., moisture-wicking or anti-microbial treatments) to create functional sportswear.
3. **Medical Textiles:** Garments for healthcare professionals and patients, such as scrubs, surgical gowns, and patient apparel, require specific material sourcing and hygienic manufacturing processes.
4. **Industrial and Uniform Wear:** Heavy-duty or protective clothing, such as fire-resistant garments or high-visibility work wear, is produced with specialized materials and precise standards.
5. **Military and Tactical Gear:** The production of military garments requires durability, comfort, and often unique features like camouflage patterns, which involve specific textile technologies"



**Ramana Rao et al.,****Apparel Industry Trends**

“The apparel industry is constantly evolving, with new trends emerging each season. Here are a few of the key trends to watch in the industry in the coming year:

Trend #1: Fashioning the Future with Sustainability

Consumers are becoming increasingly conscious of the environmental impact of the clothing they purchase. As a result, sustainable fashion, also known as eco-fashion or ethical fashion is becoming an increasingly important trend in the industry.

Trend #2: Revolutionizing Fashion with Athleisure

Athleisure, a trend that combines athletic and leisure wear, has been revolutionizing the fashion industry in recent years. This trend has been driven by the increasing popularity of comfortable, functional clothing worn both in and out of the gym.

Trend #3: Market Growth Headed by Women and Kids Wear

The shift in lifestyle and priorities of modern women is leading to a greater focus on self-awareness and appearance, driving growth in the women’s apparel market. As they are becoming more conscious of their fashion choices, the demand for trendy and fashionable clothing is increasing.

Case-study

The market for kids’ wear is driven by factors such as the increasing number of working mothers and the growing trend of parents investing in high-quality clothing for their children. According to a recent report by Wazir Advisors, India’s kids’ wear market is expected to reach INR 1,23,000 Crores by 2023, growing at a CAGR of 13%.

Trend #4: Style and Functionality is Key to Modern Consumers’ Wardrobe

Functionality is especially important for active wear and athleisure, as consumers seek clothing that can keep up with their busy lifestyles and support their physical activities. Fashion, on the other hand, is essential in creating a unique and personal style. Consumers are looking for clothing that reflects their personal tastes and preferences and makes them stand out.

Trend #5: The Growing Era of Digital First Brands

The apparel industry is currently experiencing a shift towards digital-first brands. These brands prioritize online sales and digital marketing over traditional brick-and-mortar retail and are utilizing technology to create a seamless and personalized shopping experience for consumers. One of the biggest advantages of digital-first brands is their ability to reach a global audience through e-commerce. These brands can sell directly to consumers, bypassing traditional retail channels and cutting down on costs. This allows them to offer a wide range of products at competitive prices”.

Current & Future Challenges and Problems in the Apparel Industry [21]

“The new trends, changing consumer habits, and market shifts have shed light on the new challenges the e-commerce apparel industry is facing in 2025

- Difficulty in managing customized order allocation and inventory sync
- Unable to align warehouse operations manually
- The impact of COVID-19 and the need to adapt to the changing retail landscape and consumer behavior
- Inability to manage deliveries, leading to a higher % of Customer Initiated Returns (CIR)
- Hard to align multiple sales channels and offline stores alongside
- Back-breaking for e-commerce platforms to manage multiple vendors
- Untimely and inefficient delivery of products
- No stock rotation leading to outdated stock
- The increased cost of Reverse Logistics
- The need to navigate the complex and ever-changing regulations and compliance requirements
- Poor management of returns and cancellations



**Ramana Rao et al.,**

- Difficulty in predicting and managing demand, inventory, and logistics”.

Evolving Practices as a Solution to Challenges in the Apparel Industry

“Starting up your own fashion e-commerce business has never been easier, especially post the pandemic. Right from managing the inventory and warehouse operations to timely updating the digital attire of an e-commerce store, the aspects are many. But with the advancement of technology, it has become important to adopt some upcoming practices, aligning the sales with your operations. Following are some of the upcoming e-commerce practices that act as a solution to the challenges you are witnessing during these tough times.

Delivering Omni-channel Experiences

It has become imperative to provide customers with a seamless experience at all touch points. Integrating and aligning offline and online channels together helps both businesses and customers develop better relationships. Omni channel retail offers unhindered shopping experiences to customers and helps keep the inventory and stock levels uniform. With its advanced Omni-channel solution, Uni-commerce has enabled effortless business operations & tremendous growth for Iconic Fashion India.

Serving Directly With the D2C Business Model

D2C is quite a recent approach wherein brands deal with customers directly, eliminating intermediaries. While many new brands are adopting this strategy, some established brands are switching from traditional business models to D2C models. According to Unicommerce’s e-commerce Q3 2022 trends report, the e-commerce industry witnessed robust order volume growth of 48.3% through the brand websites, while marketplaces recorded a 21.5% order volume growth. By addressing these challenges strategically, apparel companies can not only overcome the existing hurdles but also position themselves for long-term success in a rapidly changing market”.

Opportunities in the Apparel Industry

- “The Indian textile and apparel market has significant growth potential, with the industry projected to reach \$190 billion by 2025-26 [21]
- Government policies and regulations have directed their focus on this industry. Mr. Piyush Goyal, the Minister of Textiles, announced that the Indian government plans to create 75 textile hubs across the country. Not to mention the government has also reduced the custom duty rates on caprolactam, nylon chips, and nylon fiber and yarn to 5%.
- These regulations have created plenty of opportunities for the Textile and Apparel Industry in the e-commerce sector”.

CONCLUSION

“India's Garment manufacturing process is an intricate blend of traditional techniques and modern practices. It is characterized by its rich history of craftsmanship, its growing emphasis on sustainability, and its significant role in the global apparel supply chain. Despite challenges like competition and labor issues, India remains a key player in the global garment industry due to its vast resources, skilled workforce, and evolving technology infrastructure”. “The number one goal is to make these youth from marginalized communities competent, capable and confident in gaining employment or starting entrepreneurial ventures and thereby become accepted as an important and respected part of their community and society. The Garment manufacturing process encompasses various technical and creative steps, each crucial for delivering a finished product that meets the desired specifications. Whether for fashion, sports, or industrial applications, the principles remain consistent but adapt to the unique requirements of each sector. *Centurion University* plans to expand its reach internationally, starting with Australia with which it already has a long-standing association. The Aussie brand offers a wide range of products from designer clothes to





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customized uniforms to highly specialized medical garments. Towards this goal, the Apparel Manufacturing Unit (SMO) Unit at CUTM is constantly evolving to keep abreast with the latest technology and demands of the industry. In 2024 Centurion University is placed to launch its own medical apparel production in response to the demand of the market. The Unit would design and deliver these highly specialized products and at the same time offer skill training courses on their manufacturing to the marginalized youth in Odisha and Andhra Pradesh”.

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From Screening to Survivorship: Cutting-Edge Approaches in Breast Cancer Treatment

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ABSTRACT

Breast cancer is solitary of the most rampant cancers all-inclusive, necessitating uninterrupted advancements in its detection, treatment, and survivorship care. This review discusses topical innovations in breast cancer management, including novel early detection techniques, such as digital breast tomosynthesis (DBT), liquid biopsy, and the application of artificial intelligence (AI) in mammography. Advances in treatment, particularly immunotherapy and targeted therapies like PARP inhibitors and CDK4/6 inhibitors, are smoothing personalized medication. The significance of survivorship care and addressing hereditary risk factors through genetic counseling is also explored, emphasizing the need for a holistic, patient-centered approach to breast cancer care.

Keywords: Genetic counseling, Digital breast tomosynthesis (DBT), Liquidbiopsy, Multigene panel testing, High-risk breast cancer, Antibody-drug conjugates (ADCs), Molecular breast cancer therapy,

INTRODUCTION

Breast cancer remains one of the most momentous health challenges globally and is the leading cause of cancer-related morbidity and mortality amongst women [1]. Detection rates are enhanced by these novel approaches, particularly in high-risk populations and women with dense breasts, which allows for earlier and more accurate interventions. Breast cancer treatment has evolved dramatically in tandem with improved detection methods. The incorporation of immunotherapy and targeted therapies marks a noteworthy shift from traditional chemotherapies by offering more personalized and effective treatment options. Promising results have been seen in immunotherapy, principally for antagonistic subtypes like basal-like breast cancer [2], but targeted therapies tailored to specific genetic profiles are redefining treatment paradigms [3]. As survival rates continue to improve, there is a growing



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emphasis on enhancing the quality of life for breast cancer survivors. Long-term effects of treatment, including cognitive impairments, cardiovascular risks, and psychosocial challenges, underscore the need for comprehensive survivorship care plans [4]. Additionally, advancements in genetic research, including the identification of new susceptibility genetic factors beyond BRCA1 and BRCA2, are enhancing risk assessment and personalized prevention strategies [5]. This review article aims to explore the state-of-the-art developments in breast cancer care, focusing on early detection techniques, treatment innovations, survivorship considerations, and the impact of genetic factors on risk management. By exploring these advancements, we can better understand the evolving landscape of breast cancer management and the promise it holds for improving patient outcomes.

METHODS AND MATERIALS

Literature Search Strategy

A methodical literature review was conducted to characterize relevant studies and publications on recent advancements in breast carcinoma detection, treatment, survivorship care, and hereditary risk management. The following databases were used to gather peer-reviewed articles and clinical trial data:

- PubMed
- Google Scholar
- Web of Science
- Scopus

The search terms included:

- ✓ Breast cancer detection innovations
- ✓ Digital breast tomosynthesis
- ✓ Artificial intelligence in mammography
- ✓ liquid biopsy in detecting Breast cancer
- ✓ Immunotherapy in breast cancer
- ✓ PARP inhibitors
- ✓ CDK4/6 inhibitors
- ✓ Breast cancer survivorship care
- ✓ BRCA mutations in breast cancer
- ✓ Hereditary

Early Detection Techniques

Novel Screening Technologies

Premature detection is crucial in improving breast cancer survival rates, and several advanced screening methods have been developed to enhance traditional approaches.

Digital Breast Tomosynthesis (DBT):

DBT, or 3D mammography, improves upon traditional 2D mammography by creating three-dimensional images of the breast. This technology significantly increases the detection rate of invasive cancers, particularly in women with dense breast tissue, and reduces false-positive recalls [1].

Contrast-Enhanced Spectral Mammography (CESM):

CESM uses intravenous contrast agents to highlight areas with increased blood flow, a common indicator of malignancy. It is particularly useful for high-risk patients and women with dense breasts, as it can detect cancers that might be missed by conventional mammography [2].

Artificial Intelligence (AI) in Mammography:

AI and machine learning algorithms are increasingly used to assist radiologists in interpreting mammograms. AI systems can improve detection accuracy, reduce false positives, and streamline diagnostic workflows, providing a valuable tool to enhance human decision-making in breast cancer screening [3].



**Kanakala Prathibha Malini et al.,****Liquid Biopsy**

Liquid biopsy represents a promising non-invasive technique for detecting and monitoring breast cancer. By analyzing circulating tumor DNA (ctDNA) and circulating tumor cells (CTCs) in blood samples, liquid biopsy offers the potential for early diagnosis and personalized treatment adjustments based on real-time tumor genetics. Although still under development, it holds significant promise for earlier, less invasive detection and monitoring of breast cancer [4].

Advances in Breast Cancer Treatment**Immunotherapy**

Immunotherapy has gained attention in breast cancer management, particularly for aggressive subtypes such as triple-negative breast cancer (TNBC) [5].

Checkpoint Inhibitors:

Drugs like atezolizumab (Tecentriq) and pembrolizumab (Keytruda) block immune checkpoint pathways that tumors exploit to avoid detection by the immune system. When combined with chemotherapy, these drugs have shown improved outcomes, particularly in patients with metastatic TNBC [6].

CAR-T Cell Therapy: CAR-T cell therapy involves genetically modifying a patient's T cells to target specific antigens on cancer cells. Though still in its early stages for breast cancer, early clinical trials show promise in treating HER2-positive breast cancer [7].

Antibody-Drug Conjugates (ADCs):

ADCs are precision therapies that deliver cytotoxic agents directly to cancer cells. Trastuzumab deruxtecan (Enhertu) has demonstrated efficacy in HER2-positive breast cancer, targeting cancer cells while minimizing damage to healthy tissue [8].

Targeted Therapies

Personalized treatment based on the genetic makeup of tumors has led to the development of targeted therapies that offer more effective and less toxic options compared to traditional chemotherapy.

PARP Inhibitors:

PARP inhibitors such as olaparib (Lynparza) and talazoparib (Talzenna) are particularly effective for patients with BRCA1 or BRCA2 mutations. These drugs work by preventing cancer cells from repairing damaged DNA, leading to cell death and improved progression-free survival [9].

CDK4/6 Inhibitors:

CDK4/6 inhibitors like palbociclib (Ibrance) and ribociclib (Kisqali) target proteins involved in cell division. These inhibitors, when combined with hormone therapy, have been shown to improve outcomes in patients with hormone receptor-positive, HER2-negative breast cancer [10].

PI3K Inhibitors:

For patients with PIK3CA gene mutations, alpelisib (Piqray) targets the PI3K pathway, which is involved in cancer cell growth. When combined with hormone therapy, alpelisib has shown efficacy in treating advanced breast cancer [11].

Survivorship and Care

As survival rates improve, attention has shifted toward long-term survivorship care and enhancing the quality of life for survivors.

Cognitive Function (Chemo Brain):

Chemo brain, a condition characterized by memory lapses and difficulty concentrating, is a common side effect of chemotherapy. Research is ongoing into interventions such as cognitive training, exercise, and mindfulness practices to mitigate these cognitive impairments in breast cancer survivors [12].

Cardiovascular Health:

Certain treatments, such as anthracyclines and radiation therapy, can increase the risk of cardiovascular disease. Cardioprotective strategies, including beta-blockers and ACE inhibitors, are being integrated into survivorship care to monitor and manage cardiovascular risks [13].



**Kanakala Prathibha Malini et al.,****Psychosocial Support**

Breast cancer survivors often experience psychological challenges such as anxiety, depression, and body image issues. Incorporating mental health services, including support groups and psycho-oncology counseling, into survivorship care plans has been shown to improve emotional well-being and overall quality of life [14].

Genetic Factors: Unraveling Hereditary Risks**BRCA1 and BRCA2 Mutations**

BRCA1 and BRCA2 are tumor suppressor genes that play a crucial role in maintaining the stability of our DNA. These genes are involved in the repair of DNA damage through homologous recombination. Mutations in these genes significantly raise the risk of developing breast and ovarian cancers [15].

Cancer Risk Associated with BRCA1 and BRCA2 Mutations:

- **BRCA1 Mutation:** Women with a BRCA1 mutation have a 55-72% lifetime risk of developing breast cancer and a 39-44% risk of developing ovarian cancer [16].
- **BRCA2 Mutation:** BRCA2 mutations carry a 45-69% risk for breast cancer and an 11-17% risk for ovarian cancer [17].

Other Cancer Risks:

- Both men and women with BRCA mutations also face a higher risk of pancreatic cancer and melanoma.
- Men with BRCA2 mutations are at increased risk of male breast cancer and prostate cancer [18].

Preventive Measures for BRCA Carriers:

Genetic counseling is essential for individuals with BRCA mutations. Preventive options include:

- **Prophylactic Surgery:** Preventive mastectomy and oophorectomy to lower cancer risk.
- **Enhanced Surveillance:** Frequent mammograms, MRIs, and clinical breast exams.
- **Chemoprevention:** Medications like tamoxifen or raloxifene can reduce breast cancer risk [19].

Beyond BRCA: New Genetic Insights

Recent advancements in genetic research have uncovered additional genes, beyond BRCA1 and BRCA2, that also increase the risk of breast cancer. These discoveries are enhancing the accuracy of genetic risk assessments and improving personalized prevention strategies for at-risk individuals.

Key Genes Beyond BRCA:

- **PALB2:** Mutations in PALB2 can significantly increase the risk of breast cancer, with studies suggesting a 33-58% lifetime risk [20].
- **CHEK2:** CHEK2 mutations are linked to a moderate increase in breast cancer risk, with a lifetime risk of 20-44% [21].
- **ATM:** Mutations in ATM can increase the risk of breast cancer, with lifetime risks ranging from 15-60% [22].

Multigene Panel Testing

Multigene panel testing has emerged as a powerful tool for assessing breast cancer risk by testing several genes simultaneously, including BRCA1, BRCA2, PALB2, CHEK2, ATM, and others [23].

Why Multigene Panels Are Important:

- **Comprehensive Risk Assessment:** Multigene panels offer a more complete risk assessment than BRCA testing alone.
- **Expanded Identification of At-Risk Individuals:** Multigene testing identifies individuals at risk who may not carry BRCA mutations but still have genetic mutations linked to breast cancer.

Personalized Risk Management:

Healthcare providers can offer personalized management plans based on genetic profiles, ranging from more aggressive preventive measures to tailored screening schedules [24].





DISCUSSION

The advancements in breast cancer care represent a paradigm shift toward more personalized, precise, and less invasive approaches to diagnosis and treatment. Early detection technologies, such as DBT, CESM, and liquid biopsy, are improving the accuracy of breast cancer examination, particularly for women with dense breast tissue or high genetic risk [25]. Immunotherapies and targeted therapies are expanding treatment options for aggressive or advanced cancers. Tailoring treatment based on the molecular and genetic characteristics of tumors represents a significant shift from the one-size-fits-all approach of traditional chemotherapy and radiation [26]. In terms of survivorship, addressing long-term effects of breast cancer treatment is essential for improving survivors' quality of life. Genetic research continues to refine breast cancer risk assessments, enabling more personalized prevention strategies [27-28].

CONCLUSION

The evolving landscape of breast cancer care offers hope through advancements in early detection, treatment, and survivorship. Personalized medicine and genetic research are driving more precise, effective, and less invasive options for patients, with continued innovation in screening, treatment, and survivorship care care will be essential in further improving outcomes for breast cancer patients and survivors, ultimately working toward the goal of reducing the global burden of this pervasive disease.

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To Identify Prevalence and Antimicrobial Susceptibility in Patients with Purulent Ear Discharge

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ABSTRACT

Otitis media is a progressive inflammatory disease affects all irrespective of age. However, high frequency could be observed in children rather than other age groups. Any suppuration of the inner ear is referred to in otitis media, although there is no special information regarding aetiology or pathogenesis [1]. Otitis media are susceptible to repeated or persistent infections, which are the main reason for loss of ability to hear. In developing countries where they are widespread suppurative forms, otitis media present a great burden on public health. Apart from the notable consequences of hearing loss, otitis media also has a negative impact on language, communication, comprehension, and behavior development in children, which can later result in issues with schooling and social behavior [3]. Hospital based Observational study performed for the duration of Twelve months. The study was conducted in the department of microbiology. The sample size consists of all subsequent ear swab specimens collected in the microbiology lab from people suffering with otitis media. In the current study 237 total samples were received in the laboratory in which major are gram negative isolates and remaining are the gram positive isolates. Out of 237, 133 were gram negative isolates as follows *Pseudomonas* spp were 101, *Klebsella* species are 19, *E. coli* and *proteus* were 8 and 5 respectively. 37 species were identified as gram positive isolates 19 were *staphylococcus* and 18 were *streptococcus pneumoniae* and 72 cultures found no growth. The moderate level resistance seen in Gentamicin, Amoxicillin, Ampicillin. There is highly resistance observed in Cefaclor.





Keywords: MRSA, ASOM, CSOM, Aural discharge.

INTRODUCTION

Otitis media is a progressive inflammatory disease occurring irrespective of age groups. But, high frequency could be observed in children rather than other age groups. Any suppuration of the inner ear is referred to as otitis media, although there is no special information regarding aetiology or pathogenesis [1]. Otitis media are susceptible to repeated or persistent infections, which is the main reason for loss of ability to hear. In developing countries where they are widespread suppurative forms, otitis media present a great burden on public health. In addition to the significant effects of hearing loss, it also has a detrimental effect on language development, communication, comprehension and behavior at an early stage which may lead to disadvantages in education and societal conduct in later ages [3]. In addition to early detection techniques for otitis media prevention and treatment, an ideological knowledge on the magnitude, of pathophysiology, and role of infectious microorganisms is required [4].

Otitis media is a range of conditions with three main subtypes.

1. Acute otitis media (AOM)
2. Chronic otitis media (COM)
3. Otitis externa

Acute otitis media is an inner ear infection that is widely prevalent in children, though it can also strike adults. For both children and adults, inner ear infections can have different outcomes. Because of deficiencies in their anatomy or immune systems, children are more susceptible to AOM, whereas adult ear infections are typically persistent [5]. There are three types of acute otitis media: recurrent acute otitis media, acute non-suppurative otitis media, and acute suppurative otitis media. Pus develops in the middle ear in cases of acute otitis media. Tympanic membrane or bone erosions can disseminate an infection from the middle ear, leading to consequences including hearing loss in the affected person [7]. Depending on its severity, acute otitis media may persist ranging from three weeks to three months. The majority of children's acute otitis media resolves on its own after receiving antibiotic medication. Upper respiratory tract infections typically occur prior to acute otitis media because they cause swelling and congestion of the nasal membranes and the eustachian tube. Although it usually affects children, adults can also get acute otitis media [8]. However, the infection is preceded by URTI in adults and immature ages [9]. CSOM is a tenacious inflammation of mastoid air cells present in the middle ear. Bacteria, virus, & fungus induce intermittent or recurrent infected discharge via perforation or through the tympanic membrane which is not intact and is present for more than three months. It also causes mucosal lining inflammation and typically culminates in the loss of tympanic membrane and ear ossicles either completely or partially [12]. Chronic otitis media is a potentially serious disease by virtue of its complications. In chronic cases, complications are usually due to gradual wear and tear of the bone, increasing the risk of damage to the facial, labyrinthine, and dural nerves. Intracranial complications (ICs) used to occur in 2.3 – 4 % cases before the era of antibiotics [13]. Otitis externa is an inflammatory condition of the external auditory canal. It is also known as swimmer's itch. It is commonly seen in persons who are frequently exposed to water like swimmers. It is commonly caused by bacteria or fungus.

MATERIAL AND METHODS

Hospital based Observational study performed for duration of twelve months. All the subsequent ear swab specimens collected from otitis media patients in the microbiology lab comprise the sample size. The study was conducted in the microbiology department.

Inclusion Criteria: This study will include every ear swab sample from suspected otitis media patients, including those with acute and chronic suppurative otitis media.

Sampling collection: An ear sample will be taken from the patient in the department of ENT and is forwarded to the microbiological lab for further analysis.





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Processing of specimen: The obtained specimen shall be sent right away to the laboratory in the microbiology department for processing. One swab will be used for Gram staining, while the other swab will be used to inoculate sterile blood agar (BA) and MacConkey's agar (MA) plates before being incubated. The emergence of bacteria colonies will be identified on the basis of standard procedures.(25) For the identification of bacterial isolate further processed with gram stain and biochemical test will be performed

RESULTS

In the current study 237 total samples were received in the laboratory in which major are gram negative isolates and remaining are the gram positive isolates. Out of 237, 133 were gram negative isolates as follows *Pseudomonas* spp were 101, *Klebsiella* species are 19, *E. coli* and *Proteus* were 8 and 5 respectively. 37 species were identified as gram positive isolates 19 were *Staphylococcus* and 18 were *Streptococcus pneumoniae* and 72 cultures found no growth. *Staphylococcus aureus* and *Streptococcus pneumoniae* were highly sensitive for Cephalexin, Levofloxacin, Linezolid and Vancomycin. Moderate level sensitivity were observed in the Clindamycin, Gentamicin, Ciprofloxacin, Cotrimaxazole and Cefotaxime. High level resistance were found Azithromycin and Erythromycin. *Staphylococcus aureus* shown resistant to the Cefoxitin which indicates the Methicillin *Staphylococcus aureus* found (MRSA). *Pseudomonas* spp, *Klebsiella* spp, *E. coli* and *Proteus* spp exhibits high sensitivity for the Amikacin, Ciprofloxacin, Levofloxacin, Imipenem and Piperacillin/ Tazobactam. Moderate level sensitivity shown by the Amoxicillin and Gentamicin. Resistance is high towards Ampicillin, Azithromycin, Cefotaxime and Cefaclor. Moreover, *E. coli* and *Proteus* were moderate sensitivity for Azithromycin and cefotaxime observed.

DISCUSSION

It is difficult to identify the organism causing the infection because of the unideological variations in the pattern of otitis media bacteriological isolates and microorganisms' sensitivity to drugs. In the present study, 165 (71%) cases were cultures growth occurred and 72 (29%) were cultures no growth occurred. According to this study, 165 culture positive cases were identified. *Pseudomonas aeruginosa* 101 (43%) is the most common and the major isolate which is followed by *Klebsiella pneumoniae* 19 (8%), *Staphylococcus aureus* 18 (8%), *Streptococcus pneumoniae* 15(7%), *E. coli* 8 (3%), *Proteus mirabilis* 5 (2%) and also containing the no growth cultures are 72 (29%) due to presence of anaerobic bacterial isolate or fungi or absence of bacterial isolates. In 2019, Chauhan *et al* studied bacterial and fungal agents causing CSOM among patients attending a tertiary care hospital in Uttarakh and. According to their study, the prevalence of *P. aeruginosa* was found to be 45.71%, *Staph aureus* (31.42%), *P. mirabilis* (14.28%), *E. cloacae* (5.71%) and *S. paucimobilis* (2.8%) while the prevalence of fungal agent was found to be 36.36%, *A. fumigatus* was found to be predominant fungal isolate. While, 30.30% *A. niger*, 18.18% *C. albicans*, 6.06% *A. terreus*. *Staphylococcus aureus* and *Pseudomonas aeruginosa* isolates showed resistance to most of the antibiotics studied [29].

In present study, *Pseudomonas aeruginosa* 101 (43%) is the prime isolate *aeruginosa* and commonest isolate followed by *Klebsiella pneumoniae* 19 (8%), *Staphylococcus aureus* 18 (8%), *Streptococcus pneumoniae* 15(7%), *E. coli* 8 (3%), *Proteus mirabilis* [5] (2%) and also its antimicrobial sensitivity pattern. *Pseudomonas aeruginosa* shows highly sensitivity for Imipenem and Piperacillin/ Tazobactam and shows slightly resistance to Amikacin, Ciprofloxacin and Levofloxacin. The moderate level resistance seen in Gentamicin, Amoxicillin, Ampicillin. There is highly resistance observed in Cefaclor, Cefotaxime and Azithromycin. According to the study from Saranya *et al* on Bacteriological and mycological profile of CSOM in tertiary hospital on 2015 they found *P. aeruginosa*, *Staph aureus*, *K. pneumoniae*, *P. mirabilis*, *Escherichia coli* and also followed by some Nonfermenting gram negative bacilli and *Pseudomonas* spp shows the highly sensitive for Amikacin, Piperacillin/tazobactam, Ciprofloxacin and Imipenem. The resistant antibiotics are Cefotaxime with respective percentages also observed in some other studies from Ashok S *et al* on 2018 also shown that Amikacin and Ciprofloxacin are highly sensitive and followed by resistant pattern was





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Azithromycin is major one. As seen in previous studies some present resistant antibiotics show the sensitive in Loy study on 2002.

Klebsiella Pneumoniae shows the 100% sensitive to the Amikacin, Ciprofloxacin, Levofloxacin, Imipenem, and Piperacillin tazobactam. Moreover moderate level resistant antibiotics are Amoxicillin, Cefotaxime, Gentamicin and Azithromycin. Resistant antibiotics are Cefaclor, Ampicillin with respective percentages. *Klebsiella spp* shows the 100% sensitive to the Amikacin, Ciprofloxacin, Gentamicin, Levofloxacin, Imipenem, and Piperacillin tazobactam. Moreover moderate level resistant antibiotics are Amoxicillin, Cefotaxime and Azithromycin. Resistant antibiotics are Cefaclor, Ampicillin with respective percentages. According to the study of Vineetha et al on 2021 observed imipenem is 100% sensitive and followed by Amikacin, Amoxicillin are 60-80% susceptible and shown less susceptibility to Cephalosporin's. *S. aureus* shows majorly sensitive to Vancomycin and Linezolid 100% and the moderate level of 60-80% sensitivity pattern shown antibiotics are Cefotaxime, Levofloxacin, Clindamycin, Ciprofloxacin, Gentamicin, Erythromycin, Cephalexin and Cefoxitin. Resistant observed in Azithromycin.

CONCLUSION

In developing nations like India, otitis media is another issue that need attention. Remember that our research emphasizes the significance of identifying the microbes causing otitis media and accurately testing for antibiotic susceptibility in pathogens, both of which are critical for diagnosing the illness and prescribing the appropriate antibiotics. This additionally prevents several hospital-acquired illnesses and the emergence of treatment resistance. Systematic antibiogram monitoring will enable the hospital's department prepare an antibiotic plan, which will help ensure that antibiotics are used appropriately and prevent the emergence of resistance. On the other hand, the lack of standardized laboratory testing for β -lactamases might lead to the internal or interhospital spread of ESBL-producing bacteria that are undetected for extended periods of time.

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Table: literature of the positive cultures and no growth ones based on previous studies

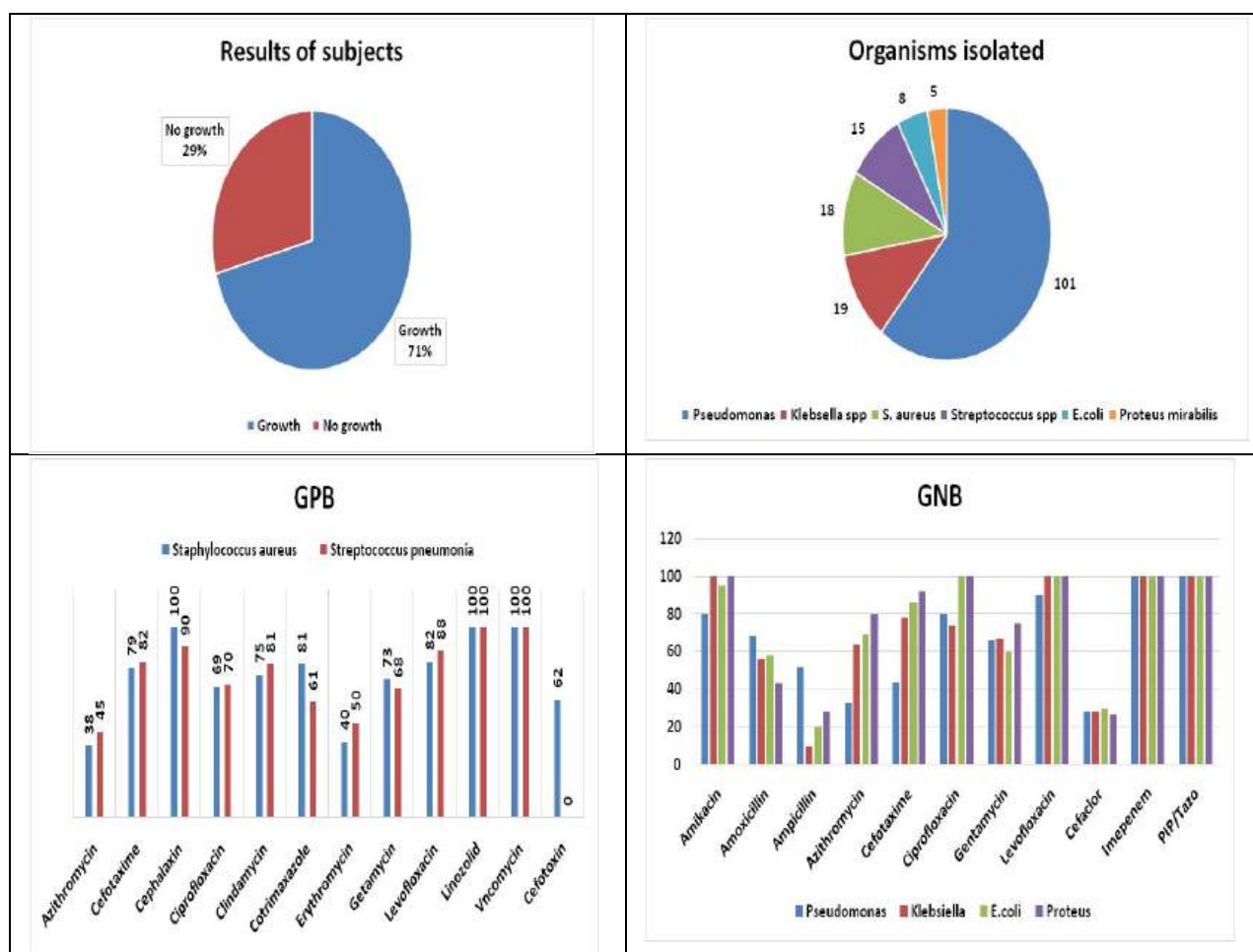
Study	Year	Positive Culture	Negative Culture
Taneja M.K. <i>et al.</i>	1995	618(84%)	118(16%)
Gulati <i>et al.</i>	1997	78(78%)	22(22%)
Gupta V. <i>et al.</i>	1998	150(95.5%)	7(4.4%)
Hiremath S.L. <i>et al.</i>	2001	126(84%)	24(16%)
Rakhee <i>et al.</i>	2014	65(91.5%)	6(8.45%)
Shetty A <i>et al.</i>	2014	46(95%)	4(5%)
Summit M <i>et al.</i>	2015	40(83.3%)	8(16.6%)



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Tariq Z <i>et al.</i>	2016	95(95%)	5(5%)
Goyal <i>et al.</i>	2018	122(93.8%)	8(6.2%)
Chauhan <i>et al.</i>	2019	56(80%)	14(20%)
Khan <i>et al.</i>	2020	209(69.7%)	91(30.1%)
Kombade <i>et al.</i>	2021	126 (82%)	27(18%)
In our study	2022-23	165(71%)	72(29%)

Organisms	Percentage%(n=237)
Pseudomonas spp	101(43%)
Klebsiella spp	19 (8%)
Staphylococcus aureus	18(8%)
Streptococcus spp	15 (7%)
E.coli	8 (3%)
Proteus mirabilis	5 (2%)
No growth	72 (29%)
Total	237 (100%)





Early Alzheimer's disease Detection by Using Resnet for Extraction of Features with SVM Tuning for Classification

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ABSTRACT

Early detection of Alzheimer's disease (AD) is vital for effective intervention and management. This study introduces a novel approach that employs a ResNet architecture for feature extraction from neuroimaging data, coupled with Support Vector Machine (SVM) tuning for classification. We utilized a dataset of MRI scans from subjects at various stages of cognitive decline. The ResNet model was fine-tuned to identify complex patterns in brain structure indicative of early AD. Features extracted from the network's final layers were then input into an SVM classifier, optimized through grid search to improve classification accuracy. The parameters are tuned and the final layer in Resnet-53 is used for Support Vector Machine (SVM) model. It is mainly used for detection of Alzheimer's, and it addresses the both binary and multiclass classification. But we are using multiclass labels are used so it is used for multiclass classifications. Bayesian optimization with Hyperopt is used in a fine tune process to find the hyperparameters space, optimizing key variables such as kernel selection and regularization to increase the performance of the model on the validation set. The proposed method is used to show the most accurate difference between normal cognitive aging and Alzheimer's disease, which is so sensitive and specific to achieve. Multimodal data is combined to increase the models performance and provides comprehensive tools for early detection.

Keywords: Tuning, Resnet, SVM, Neuro Imaging, adaptive Filters, Hyperopt.





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INTRODUCTION

To receive prompt therapy, an accurate diagnosis of the disease's major causing components is required. Several high-dimensional pattern categorization approaches have been built using computational anatomy, functional neuro imaging, and neuropsychological analysis methods. In comparison to group analysis, these methodologies reveal that individual classifications can lead to a better accuracy rate for diagnosing diseases. Early detection can help prevent disease progression. According to the 2001 census, India had 76 million persons aged 60 and up. India has a higher risk of dementia than other emerging countries. Furthermore, this growth rate is predicted to increase year after year. Because of the high dimensionality and over-segmentation problem, most conventional ADNI illness prediction processes are static in feature ranking and data categorization. As the amount of characteristics and classification error rate grow, it's more important than ever to detect and prevent the onset of Alzheimer's disease so that it can be diagnosed early. [8] The use of structural magnetic resonance imaging (MRI) as a biomarker for early diagnosis of MCI, LMCI, CN and AD-related alterations, as well as predicting disease progression rate, has showed promise.

AD Disease Detection using Traditional CNN

It describes a process in which MRI samples are converted into JPEG slices using MATLAB, rescaling to 8-bit pixel size from the original 14-bit size. The three blocks that comprise the proposed model are an ensemble of convolutional, ReLU activation, & max pooling layers in each block. A flattening conv layer, two fc layers, two sets of convolutional and max pooling layers, and a softmax/sigmoid classifier are all included in the design. MCI, NC, & AD are the output classifications [5]. The input is a 256x256 grayscale image that undergoes conv layers with 32 mappings for features. The filter size is 3x3, and ReLU activation. Max pooling is applied with a size of filter 3x3, resulting in image dimensions of 84x84x32. Subsequent layers include a 2nd conv layer with 64 FM & a 3rd convolutional layer with 128 FM, connected to max pooling [6]. The flattened layer has 8192 parameters. A conv layer containing 256 1x1 feature maps is used as the fifth layer, which is fully coupled to the layer before it. The last layer is a completely linked softmax output layer of 10 potential values, while the sixth surface is an entirely linked layer with 256 units. The overall architecture for this methodology is presented in figure 1.

AD Disease Detection using Integrated CNN with CAD

A CAD (Computer-Aided Diagnosis) device utilizing a convolutional neural network (CNN) was developed to distinguish Alzheimer's Disease (AD) from normal control (NC) patients. The CAD system analyzed 18FDG-PET images and employed a CNN to extract relevant features. The pictures were divided into several 2D slices and clustered at regular intervals without crossing. The ADNI dataset was used to assess the proposed CAD system. The suggested CNN-based CAD system performed exceptionally well in simulations, outperforming other techniques in terms of precision in classification and resilience [7]. The findings strongly indicated that the proposed system had a higher potential for effectively differentiating AD from NC patients.

Alzheimer's Disease Detection Using Customized CNN

Data pre-processing was performed on the OASIS dataset to address the influence of different image sizes. [3] Image resizing using OpenCV Python was employed to reduce training time, while image denoising was conducted to improve model performance. The dataset was labelled for binary classification based on CDR 0 | 1, representing Non-Demented and severe Alzheimer's cases, respectively. An equal number of patients with Alzheimer's Disease and those without dementia were included in the training and testing datasets, which were divided into 8:2 ratios and developed a 12-layer CNN structure to classify and identify Alzheimer's Disease in binary form. [2] Model used data pre-processing methods such as picture scaling and image denoising for our investigation, which used the OASIS dataset [8]. The suggested model combines machine learning and deep learning techniques. It performs better



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than four previously trained CNN models and a pre-existing 8-layer CNN model. Model intend to broaden our investigation in future work and concentrate on the untimely diagnosis of AD using multiple classification classes using the OASIS dataset. Figure 2 presents the Customized CNN architecture.

Alzheimer's Disease Detection Using Hybrid Models:

A hybrid signal methodology called HEMRDTL is proposed for the analysis & classification of AD. [4] The model combines EEG-Fused CT/MRI data and utilizes transfer learning with a VGG-19 TranL deep neural network. The HEMRDTL model outperforms other transfer learning models in terms of accuracy. Future research using genetic biomarkers & OCT images for early detection of AD is mentioned, highlighting the differentiation of the eye region in individuals with AD and the relevance of genetic biomarkers for diagnosis and prognosis [9]. Obtaining a series of OCT images showing people with AD is a goal for further research in this important area. Leveraging additional data sources could enhance the precision & viability of early AD detection. Figure 3 presents the Hybrid model detection

One of the newest approaches to managing high-dimensional information and distinguishing between healthy people and AD patients is using machine learning (ML) techniques. The benefit of the method known as machine learning is the effectiveness of a proficient system: given adequate data, the algorithm can be trained to learn a tremendous amount of knowledge in a relatively short period (the learning process usually may take a few minutes to a few days at most); in contrast, to train an experienced neurologist/clinician frequently requires years of hard work and internships. The programme backed by machine learning may significantly lower the cost of diagnostics [10]. The decision-making phase of such classification or recognition only takes a few seconds, which is now one of the most alluring advantages over a traditional doctor. A typical ML technique typically explores features to discover the most critical departing patterns between MCI/AD and normal control subjects.

Datasets Available

AIBL (Australian Imaging and Biomarker Lifestyle): The AIBL PiB and MRI images were captured using ADNI methods, but no post-processing was used. With the help of funding from the Alzheimer's Association, this data publication has become possible. The AIBL dataset utilized in this investigation included 37 participants' 3T T1-weighted MRI scan results, which included 25 sMCI and 12 pMCI. The study collects a wide range of participant data, including demographic information, medical history, cognitive assessments, blood samples, genetic information, brain imaging (MRI and PET scans), and cerebrospinal fluid (CSF) samples.

ADNI (Alzheimer's Disease Neuroimaging Initiative): The dataset utilized in this investigation was given by the ADNI (AD Neuroimaging Initiative) study. The most often used dataset for research in this area is ADNI. Its major objective is to ascertain if it is feasible to monitor AD progression by combining neuropsychological, clinical, and other tests with MRI, PET, and other biological markers. [1] The public-private collaboration-based investigations ADNI1, ADNI-GO, and ADNI2 are continued in ADNI3, which was previously sponsored. The ADNI study collects a wide range of data from participants, including clinical and demographic information, neuropsychological assessments, medical history, genetic data, blood samples, cerebrospinal fluid (CSF) samples, structural and functional MRI scans, and positron emission tomography (PET) scans. The dataset also includes data from various biomarker assays, such as amyloid beta and tau protein measurements.

Literature Survey

Vijeeta Patil *et al.* [11] have focused on different transfer learning methods and applied them to deep learning. The data was collected from Kaggle and ADNI, where 6k samples are present in the dataset. Here the data contains four different modules while extracting the data will be examined by combining the whole module. The data is initiated by inputting the data to the feature extraction mode. At the initial stage, the data need to be mapped then the pooling of features is generated. The process is continued, and finally, the data is flatter for classification. The data is fully connected in the next stage, and the classification is performed based on weights. Finally, the data is in a probabilistic mode, where the weights are generated based on the types. Identifying neuron diseases at every stage is an essential



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task for everyone. Alzheimer's Disease is tuff and difficult to cure, so it needs immediate attention for identification. M Leela *et al.* [12] HEMRDL model works with two acquisition and transfer learning phases called VGG19. The data was collected from OASIS, which contains both diseased and healthy person MRI. In data acquisition, the model is generated based on images, and analysis is made and created in a graph format. Then the data is inputted into a pre-processing stage, where it removes all unwanted data in two forms image and graph. Parallelly, VGG19 is applied to images, and based on threshold values, new patterns are generated. The data is now ready for feature extraction, combining transfer learning and pre-processing. The extracted features of images and graphs are connected to classification, where the fc is applied in three stages, and the four different phases are retrieved. Finally, the data is evaluated based on the reports and doctors' analysis.

The brain is the main part of controlling the whole body with the help of neurons. Alzheimer's Disease is related to the brain and can cause serious attacks if not cured at the initial stage. Noman Raza *et al.* [13] have proposed a transfer learning method used in the Convolution model where the Disease can be identified initially. The dataset contains 1k images related to MRI from ADNI. It contains more than four categories. The data were pre-processed to remove unwanted data, and MRI processing to 2d slices. The data is now a gm slice, classified based on the deep neural networks with transfer learning. [14] The CNN contains 15 layers where parallelly the transfer learning denseness is used. Finally, the data is predicted based on the four categories. Hence the performance is increased based on the image segmentation with good accuracy.

Objectives

Objective 1: To implement tuned pre-trained model, ResNet for performing feature extraction on OASIS data to segment the diseased cells

Objective 2: To develop Enhanced Hyperopt based transfer learning model for classification of disease. Enhanced Hyperopt technique helps the model to control the parameters of neural networks based on multi objective

Objective 3: To comparative analysis of existing Approaches with Proposed Approaches of Alzheimer Disease detection.

System Architecture

OASIS dataset which is an open access database. OASIS data contains Alzheimer related features along with the different gender wise disease prediction. Open Access Series of Imaging Studies (OASIS). The OASIS project makes available for research the datasets of brain MRI of normal and demented patients. [15] The goal is to communicate new neuro scientific discoveries and developments. The Washington University Alzheimer Disease Research Center collaborated to create this open access database. Oasis Data as (Alzheimer_s Dataset-20231129T135615Z-001) is taken. Initially Noise is reduced by using two filters combination as bilateral and Gaussian filters and used Zero Centering. Then the pre-process will be done by using Resnet-50 by adding three layers to it, top layers are frozen to calculate the weights and unfrozen layers are customized. In added three layers 2 layers are used for feature extraction and one layer is used for classification. Here Hyper optimization search space is used to for hypertunning.

Proposed Methodology

Initially, the most important features are selected using the subset selection approach by applying ensemble technique. This approach solves the problem of sparsity and inconsistency. In the next approach, to extract the features from the MRI images, hybrid segmentation is applied by combining them with the bio markers [7]. From the extracted features, the bio markers integrated with ANN to classify the Alzheimer disease are implemented and it proved that the accuracy is very efficient. The work presents two contributions to the Alzheimer disease prediction using novel feature selection and classification models. [7] Most traditional auto-classification methods, such as SVM, neural network, Bayesian model, expectation-maximization, random tree, and so on, are used to find important features and decision patterns for disease diagnosis. However, when the number of noisy features grows, these models' feature selection and pattern evaluation times and computational memory requirements grow. For disease prediction, traditional data filtering, grouping, and classification methods are unaffected by features or data size. These models are also used to classify the static data that has been trained with a lower true positive rate.





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$$\text{Normalized\_Intensity}(X_i, Y_i) = \gamma * \sum_{i=1}^K \frac{\text{Intensity}(X_i, Y_i)}{\sqrt{\sigma^2 + \epsilon}} \quad \text{----- (1)}$$

Where

γ is a learnable parameter

k is the filter size

σ^2 is standard deviation of the kernel

ϵ is avoidance parameter to handle run exception.

The final layer of our model incorporates a tuned Support Vector Machine (SVM) for classification tasks. SVMs are effective for both binary and multiclass classification, making them suitable for Alzheimer's detection, where subjects may be categorized as normal, having mild cognitive impairment (MCI), [7] or at various stages of Alzheimer's disease. To optimize the model's performance, we employ Bayesian optimization through Hyperopt, which is effective for finding the hyperparameter space. Key hyperparameters for SVMs having the choice of kernels, the regularization parameter as (C), and kernel-specific parameters (such as gamma for the RBF kernel). Through hyperparameter tuning, aims to identify the optimal combination that maximizes the model's performance on the validation set.

Dataset was collected from the ADNI Dataset, which contains four varieties of disease conditions. The pre-processing was applied for the images with seven approaches: initials with stripping the skull, segmentation, normalization, rescaling, smoothing, and augmentation. The proposed CNN model used for image classification after pre-processing included a combination of convolutional layers, max-pooling layers, dense blocks, and transition layers. The model had 4 dense blocks, each with several layers initiated in it. The convolutional layer with a 7x7 kernel and a stride of 2 was employed to extract macro-level features. These features were then passed through the dense blocks, which consisted of 1x1 convolutions for reducing inputted data for FP, and continued with 3x3 conv split layers. The extracted essential features were propagated for subsequent layers within each dense block. Transition layers are combined with activation functions such as normalizing the batch & ReLU was placed between the dense blocks. The transition layer comprised a 1x1 convolution and a 2x2 pooling layer with a pace of two to reduce feature dimensions. Finally, the features were fed into an fc-classified layer that utilized Softmax to classify. During training, starting blocks are frozen while the remaining are re-trained.

Critical tweaking is required to maximize the performance of the Support Vector Machines (SVM). Key factor that influences the quality of training point classification and the achievement of a smooth decision boundary is the *C parameter. Higher C values provide a higher bar for exact categorization, whereas lower C numbers allow for a more flexible border that admits certain misclassifications. In order to tune C, a balance must be struck to prevent the model from being over- or underfitted to the training set. Additionally, the **kernel function* choice—polynomial, linear, and radial basis function (RBF) are common choices—determines the performance of SVM. Because RBF is flexible and can be used to many types of data, it is often employed. [7] By altering kernel parameters, such as the degree in polynomial kernels and the gamma parameter in RBF, the model may be able to more accurately capture complex linkages in the data by using the tuning process in SVM. Using the *class weights option to resolve class imbalances is another crucial component. Giving the minority class a larger weight in situations when one class outnumbers the other by a large percentage aids the model in prioritizing accurate estimates for both groups. Furthermore, the **epsilon parameter* optimization in the SVM regression model influences the error-tolerance of the regression jobs. A more sensitive model that fits the training set better with a smaller epsilon might overfit the data.

RESULTS AND DISCUSSION

Figure 7 represents about the feature extraction of test images. By using two layers of Resnet. In layer 1 it checks either the extracted features are linear or non-linear. Next layer removes linear images and stores non-linear images.





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Figure 8 shows the Neural Network function and it consists of three convolutional blocks as 1, 2 and 3. Activation and batch normalization will be performed here as Relu as activation function. The above figure shows the training phases of the models. The steps of per training epoch with more accuracy and less loss will be performed during training.

CONCLUSION

In conclusion, our research into the identification of Alzheimer's disease emphasizes the critical role that machine learning methods play in obtaining precise and timely diagnoses. We have demonstrated encouraging results in accurately differentiating between those with Alzheimer's disease and those going through normal cognitive aging by utilizing a range of biomarkers and cognitive traits with sophisticated algorithms. ResNet50 is used for visual analysis and classification; features are extracted, and parameters are changed in response to differences between expected and actual class scores. Using Hyperopt and Bayesian optimization, the SVM model is optimized for Alzheimer's disease identification. Our model has good sensitivity and specificity, suggesting its promise as a trustworthy diagnostic tool—especially when machine learning techniques are applied. The use of multimodal data improves the methodology even more and advances the ongoing search for accurate and user-friendly Alzheimer's disease diagnostics. The results of this study have the potential for enabling prompt clinical treatments and enhancing the overall management of Alzheimer's disease, ultimately leading to better patient care and outcomes as machine learning and healthcare advance forward.

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Table 1: Dataset Information for Alzheimer's

S. NO	Dataset	No. of attributes or images	Class label
1.	AIBL	1335	AD, CN
2.	ADNI	94	LMCI, MCI, EMCI, AD, CN
3.	OIASIS	140,000	LMCI, SMC, EMCI, AD, CN
4.	MIRIAD	708	AD, CN

Table 2: Pros and Cons Analysis on different models.

Author	Algorithm	Merits	Demerits	Accuracy
M Leela <i>et al.</i>	VGG19, HEMRDTL	By evaluating separately, the data has acquired high performance.	By leveraging the data, the accuracy can be increased.	99%
Sheng Liu <i>et al</i>	DL	Images can be automatically detected.	Performances has to be improved.	83%
Ahila A <i>et al</i>	CNN	This model can solve several issues at a time.	The dataset was not related to humans.	96%
P C Muhammed Raees <i>et al</i>	SVM and DNN	Implemented to any application.	Based on the datasets the performance is being different.	80%





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Ahmad Salehi et al.	CNN	Combines different datasets and performance is increased.	Execution time is more because of huge datasets.	97%
Noman Raza et al.	DenseNet	By initialling the epochs, the performance can be easily estimated.	The test has been performed in the final stage, which may decrease the accuracy.	97%
M. Ghazal et al	Alex Net	Handcrafted features are not used.	Complexity of time is more because of large images.	98%

Table 3: Parameter Description

Hyper parameter	Equation	Possible Values
C	$\min (\frac{1}{2} * \sum_{i=1}^n W_i^2 + C * \sum_{i=1}^n \sum_{j=1}^n \epsilon_{ij}) - (x)$	Any fractional value on the scale of 10
Kernel	$K = e^{-\gamma \sum_{i=1}^n Input_i - \mu_{Input}^2}$ γ is a positive parameter	[RBF, Linear, Sigmoid, Polynomial]
Degree	$D = \gamma \mu_{Input} * \sum_{i=1}^n Input_i + r^d$ r is a constant term. d is the degree of the polynomial	Any positive integer
gamma		Radial bias Function

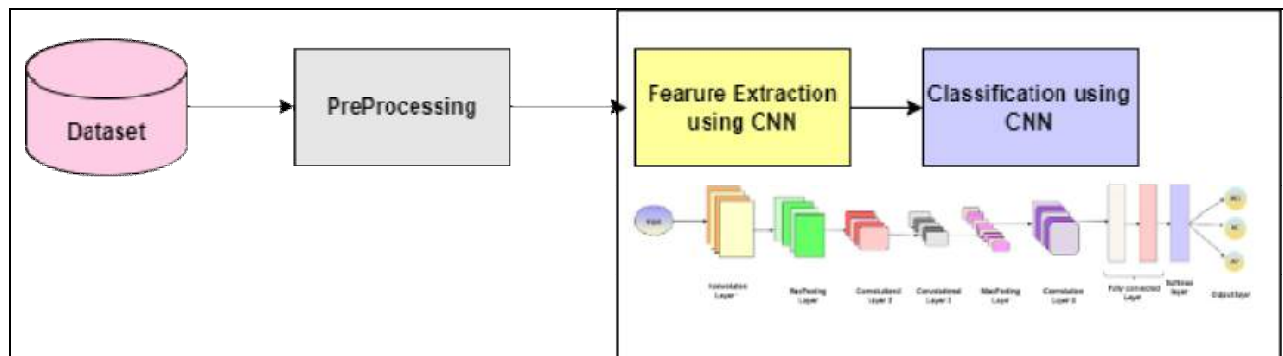


Figure 1: Traditional CNN along with Feature Extraction

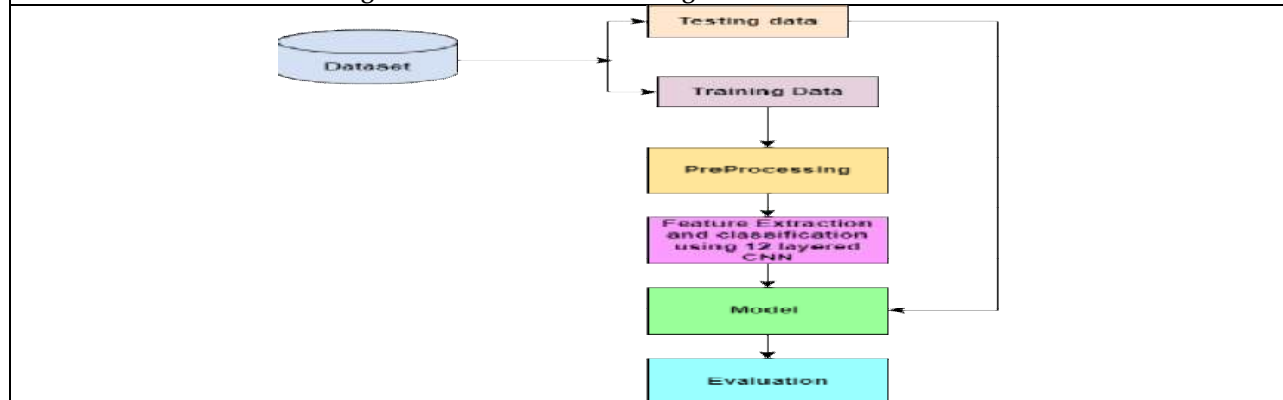


Figure 2:12-layered CNN for Disease Detection





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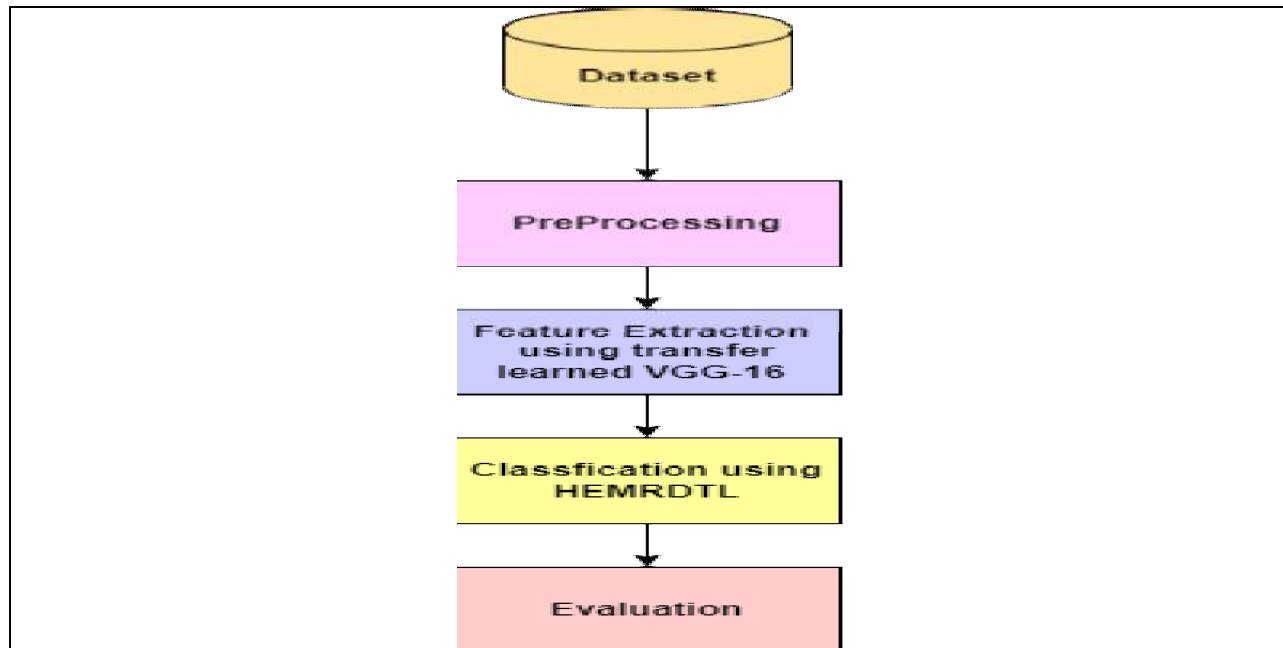


Figure 3: VGG-16 for Feature Extraction + HERMDTL for Classification

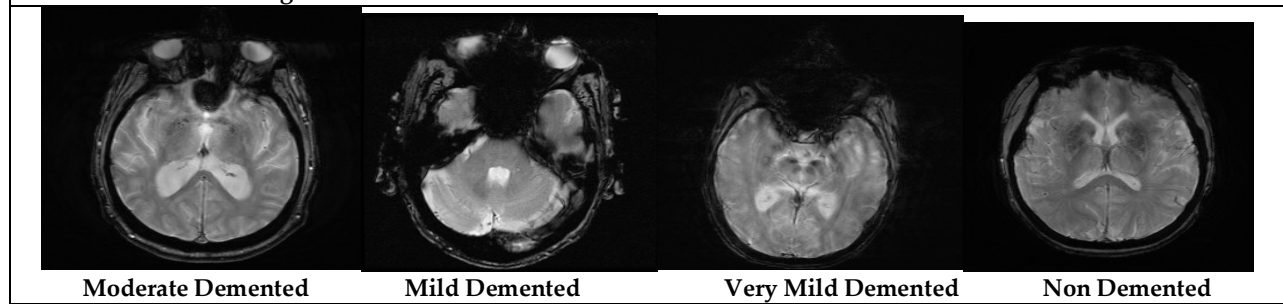


Figure 4: Different Classes Available in the OIASIS Dataset

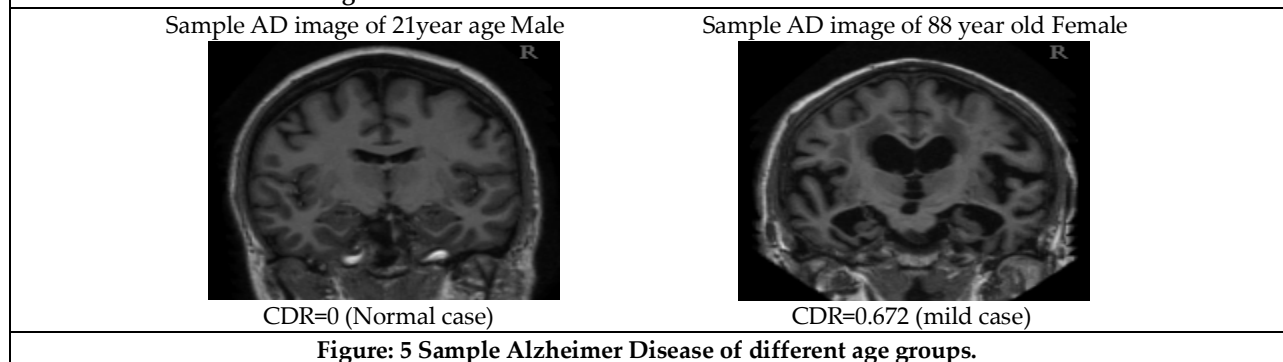


Figure: 5 Sample Alzheimer Disease of different age groups.





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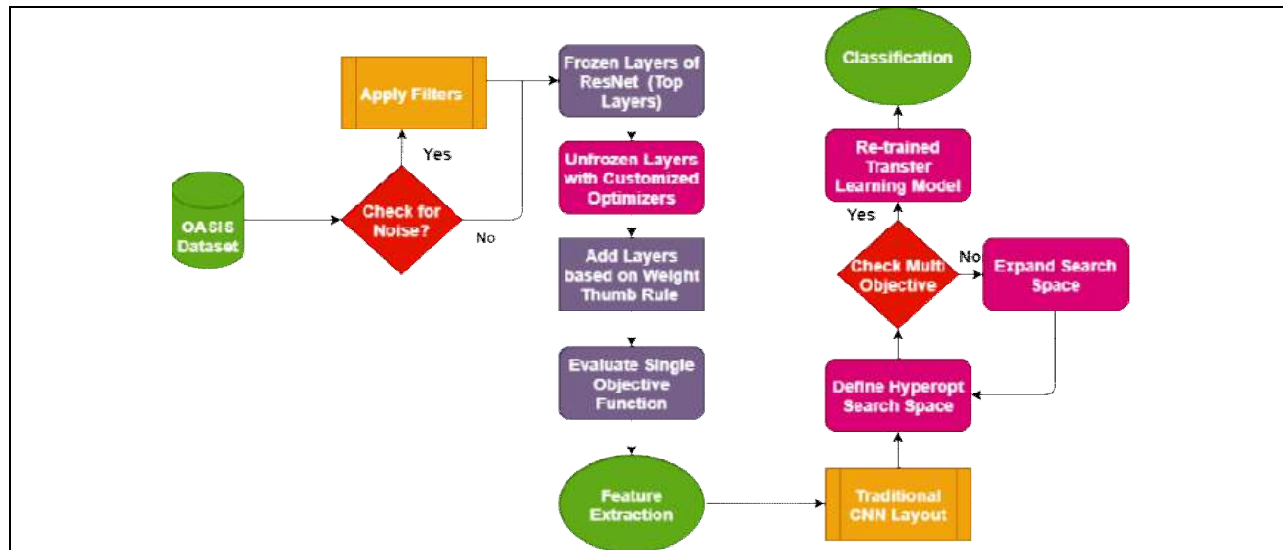


Figure 6 : System Architecture

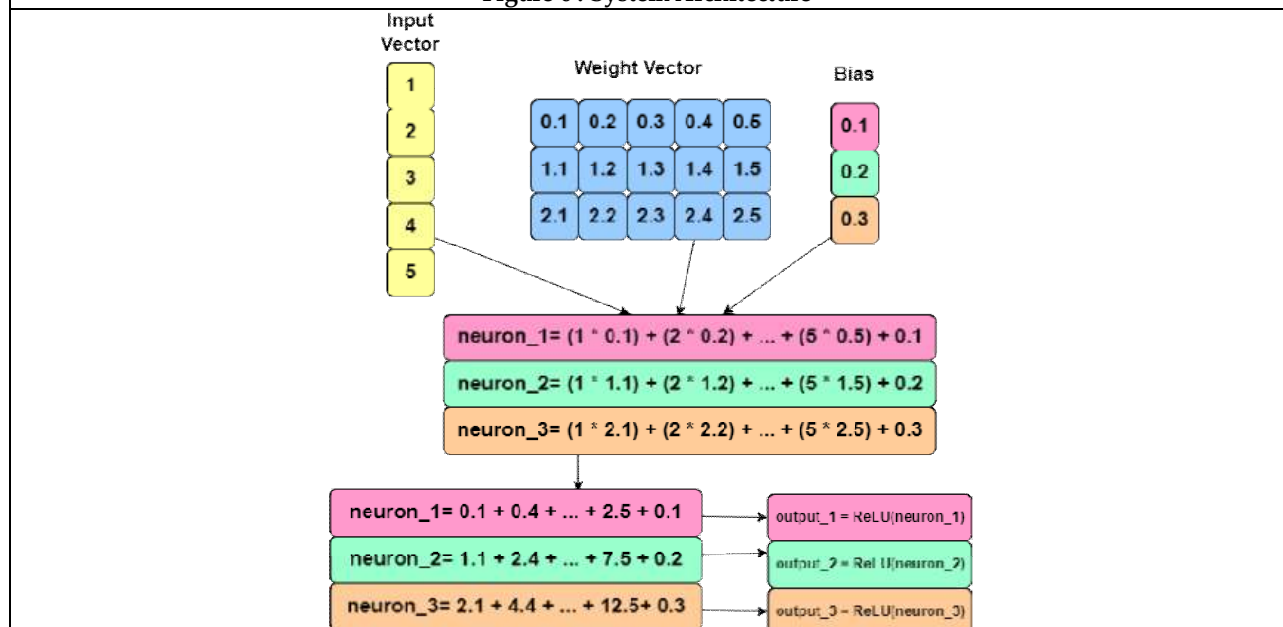


Figure 7: Working of Dense Block

```

[[ 0.      0.      0.      ... 0.      0.
  0.      ]
 [ 0.      0.      0.      ... 0.      0.
  0.      ]
 [ 0.      0.      0.      ... 0.      0.
  0.      ]
 [ 5.10785341 0.      0.      ... 0.      0.
  0.      ]
 [ 0.      0.      0.      ... 0.      0.
  0.      ]]
```

Figure 7: Feature Extraction of Test features.





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conv5_block3_1_bn (BatchNormalization)	(None, 5, 5, 512)	2048	['conv5_block3_1_conv[0][0]']
conv5_block3_1_relu (Activation)	(None, 5, 5, 512)	0	['conv5_block3_1_bn[0][0]']
conv5_block3_2_pad (ZeroPadding2D)	(None, 7, 7, 512)	0	['conv5_block3_1_relu[0][0]']
conv5_block3_2_conv (Conv2D)	(None, 5, 5, 512)	2359296	['conv5_block3_2_pad[0][0]']
conv5_block3_2_bn (BatchNormalization)	(None, 5, 5, 512)	2048	['conv5_block3_2_conv[0][0]']
conv5_block3_2_relu (Activation)	(None, 5, 5, 512)	0	['conv5_block3_2_bn[0][0]']
conv5_block3_3_conv (Conv2D)	(None, 5, 5, 2048)	1050624	['conv5_block3_2_relu[0][0]']
conv5_block3_out (Add)	(None, 5, 5, 2048)	0	['conv5_block2_out[0][0]', 'conv5_block3_3_conv[0][0]']
post_bn (BatchNormalization)	(None, 5, 5, 2048)	8192	['conv5_block3_out[0][0]']

Figure 8: Summary of Neural Network

```

149 4768 4800
1/1 [=====] - 0s 30ms/step
150 4800 4832
1/1 [=====] - 0s 25ms/step
151 4832 4864
1/1 [=====] - 0s 32ms/step
152 4864 4896
1/1 [=====] - 0s 44ms/step
153 4896 4928
1/1 [=====] - 0s 33ms/step
154 4928 4960
1/1 [=====] - 0s 41ms/step
155 4960 4992
1/1 [=====] - 0s 33ms/step
156 4992 5024
1/1 [=====] - 0s 38ms/step
157 5024 5056
1/1 [=====] - 0s 38ms/step
158 5056 5088
1/1 [=====] - 0s 41ms/step
159 5088 5120
1/1 [=====] - 1s 821ms/step
160 5120 5152

```

Figure 9 Feature Extraction

```

Epoch 43/50
161/161 [=====] - 1s 7ms/step - loss: 0.0578 - acc: 0.9798 - val_loss: 3.4031 - val_acc: 0.5215
Epoch 44/50
161/161 [=====] - 1s 7ms/step - loss: 0.0250 - acc: 0.9930 - val_loss: 3.8841 - val_acc: 0.5622
Epoch 45/50
161/161 [=====] - 1s 8ms/step - loss: 0.0501 - acc: 0.9804 - val_loss: 3.4579 - val_acc: 0.5371
Epoch 46/50
161/161 [=====] - 1s 8ms/step - loss: 0.0771 - acc: 0.9738 - val_loss: 3.4278 - val_acc: 0.5512
Epoch 47/50
161/161 [=====] - 1s 7ms/step - loss: 0.0667 - acc: 0.9773 - val_loss: 3.4487 - val_acc: 0.5598
Epoch 48/50
161/161 [=====] - 1s 7ms/step - loss: 0.1172 - acc: 0.9579 - val_loss: 3.2372 - val_acc: 0.5246
Epoch 49/50
161/161 [=====] - 1s 8ms/step - loss: 0.0322 - acc: 0.9905 - val_loss: 3.8122 - val_acc: 0.5661
Epoch 50/50
161/161 [=====] - 1s 8ms/step - loss: 0.0103 - acc: 0.9965 - val_loss: 4.5482 - val_acc: 0.5715

```

Fig: 10 Report of Epochs





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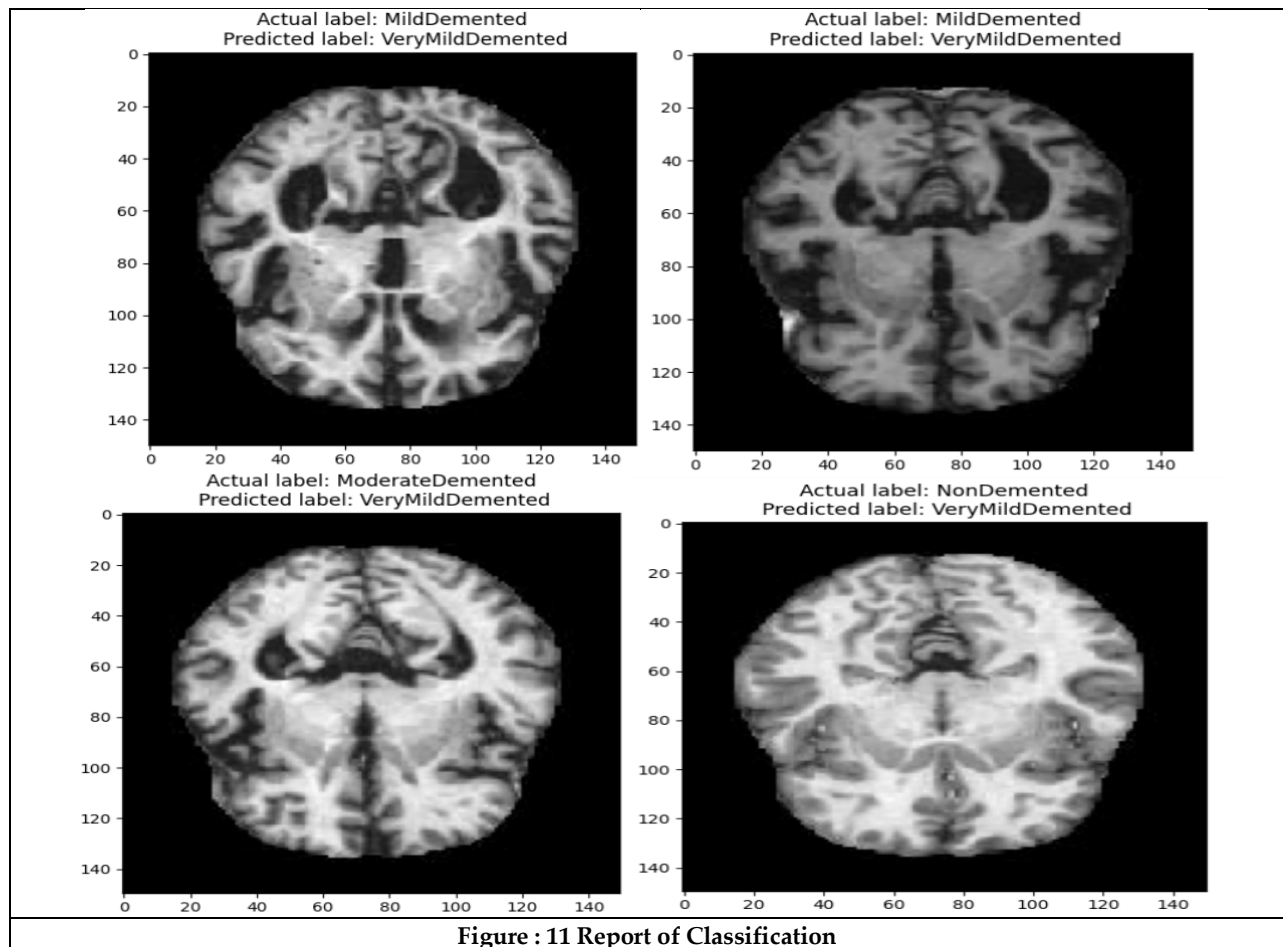


Figure : 11 Report of Classification





Classification of Retinal Diseases: Machine Learning Approach

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ABSTRACT

Retinal diseases are a significant public health concern affecting millions of individuals worldwide, often leading to vision impairment and even blindness if not diagnosed and treated promptly. Early and accurate classification of retinal diseases is critical for timely intervention and effective management. This paper presents a comprehensive review of the application of machine learning (ML) techniques for the classification and analysis of retinal diseases based on retinal images. Various ML models, data preprocessing techniques, feature extraction methods, publicly available datasets, evaluation metrics, and data synthesis techniques are explored. This research provides valuable insights into the advancements, challenges, and future prospects of using ML in retinal disease classification as we are comparing with Logistic Regression, SVM, CNN and Random Forest. The continual progress in ML techniques and the availability of diverse datasets offer promising prospects for further improving the accuracy and effectiveness of retinal disease diagnosis and management, ultimately benefiting patients and the healthcare community by working on various ML logarithms and analysis.

Keywords: Retinal Disease, Machine learning, Logistic Regression, SVM, CNN, Random Forest.

INTRODUCTION

Retinal diseases represent a substantial and growing public health concern globally, significantly impacting the quality of life for millions of individuals. These diseases encompass a diverse range of ocular conditions that affect the delicate and intricate structure of the retina, often leading to vision impairment and, in severe cases, blindness.



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Timely and accurate classification of retinal diseases is fundamental for early intervention, appropriate treatment planning, and efficient resource allocation in the healthcare system. The integration of advanced technologies, particularly machine learning (ML), has shown great promise in automating the classification and analysis of retinal diseases using retinal imaging data. ML algorithms can assist healthcare professionals by providing efficient and accurate diagnostic support, aiding in early detection, and contributing to better patient outcomes. In this research paper, we present an extensive review of ML-based approaches for retinal disease classification, encompassing various models, preprocessing techniques, feature extraction methods, datasets, evaluation metrics, challenges, and future directions. The objective is to provide a comprehensive understanding of the state-of-the-art in this critical domain and to encourage further advancements that could revolutionize retinal disease diagnosis and management.

LITERATURE REVIEW

Recently, there has been a surge of research dedicated to utilizing machine learning (ML) techniques for the classification and analysis of retinal diseases. These studies have showcased the potential of ML in improving diagnostic accuracy and expediting the decision-making process in the field of ophthalmology. Gulshan *et al.* (2016) presented a pioneering work demonstrating the effectiveness of deep learning algorithms, particularly convolutional neural networks (CNNs), in automated classification of diabetic retinopathy, setting a benchmark for subsequent studies. Abramoff *et al.* (2016) conducted a study emphasizing the significance of automated detection of diabetic retinopathy using a deep learning approach, showcasing high sensitivity and specificity in identifying the disease in retinal images. Poplin *et al.* (2018) focused on generalizing deep learning models for various retinal diseases, broadening the scope of automated classification to include age-related macular degeneration, diabetic macular edema, and glaucoma. Kermany *et al.* (2018) introduced a deep learning model trained to diagnose a wide range of retinal pathologies, demonstrating its potential for accurate multi-class classification and highlighting the benefits of transfer learning. Lee *et al.* (2017) proposed an ensemble deep learning framework for improved accuracy in the diagnosis of diabetic retinopathy, underscoring the advantages of combining multiple models for enhanced performance.

Quelleg *et al.* (2017) explored novel feature extraction methods from retinal fundus images, introducing an approach that integrated convolutional neural networks with anatomical and pathological knowledge to improve disease classification. Rajalakshmi *et al.* (2018) conducted a comprehensive study on leveraging ML techniques for the early detection of diabetic retinopathy in a teleophthalmology setup, highlighting the potential for scalable screening and timely intervention. Srinivasan *et al.* (2014) investigated the use of spectral-domain optical coherence tomography (SD-OCT) imaging and ML for the automated diagnosis of macular diseases, demonstrating the applicability of ML beyond fundus photography. Asaoka *et al.* (2018) focused on ML-based analysis of retinal nerve fiber layer defects to aid in early detection and monitoring of glaucoma, showcasing the potential for ML in precise and objective assessment of optic nerve health. Fauw *et al.* (2018) presented a study on interpretability and uncertainty estimation in deep learning models for retinal disease classification, addressing an essential aspect of trust and reliability in clinical applications of ML.

Data Preprocessing and Feature Extraction

Retinal images are complex and high-dimensional data that require careful preprocessing and feature extraction to ensure optimal input for machine learning (ML) models. Data preprocessing involves enhancing the quality of images and standardizing them, while feature extraction involves identifying meaningful patterns and characteristics from the images that are relevant for classification.

Data Preprocessing

Data Preprocessing was performed by the Image Resizing and Standardization which includes Resizing retinal images to a consistent resolution ensures uniformity in dataset dimensions, simplifying computation and improving model performance and also converted the colored images to gray scale to reduce the computational complexity and



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extract the features simply without losing critical information for disease classification. Applied noise reduction techniques, such as Gaussian blurring or median filtering, which helped to improve the image clarity by removing unwanted noise and artifacts, also adjusted image contrast to ensure that relevant features are highlighted, aiding the ML model in identifying essential patterns within the images. Normalization was done to a standardized scale to ensure numerical stability and helps ML models converge faster during training.

Feature Extraction

HOG is often used to capture gradient information within the image, providing insights into edges and shapes, particularly useful in detecting textures and structures in retinal images, we have also used Local Binary Pattern which characterizes the texture of the image, which can be vital in distinguishing different textures within retina, helping in the detection of specific retinal anomalies, applying wavelet transform enabled the representation of the image in both the frequency and spatial domains, utilizing pretrained convolutional neural networks (CNNs) like ResNet. OCT helps in Retinal Nerve Fiber Layer thickness and macular volume learnings by the comprehensive analysis. Statistical features include the basic mean, standard deviation, skewness and kurtosis of the pixel intensities which provide valuable information about the overall distribution and structure of the image.

Interpretation

Data preprocessing and feature extraction are critical steps in retinal disease classification. Preprocessing ensures that the input data is consistent and free from noise, while feature extraction extracts meaningful patterns from the images. Grayscale conversion and resizing are often essential to simplify computation, and contrast enhancement can highlight relevant features. Features like HOG and LBP help capture texture and gradient information, while deep learning features learn hierarchical representations. The choice of preprocessing and feature extraction techniques is crucial, impacting the model's ability to accurately classify retinal diseases based on the extracted features. Machine learning models are essential for the classification and analysis of retinal diseases based on features extracted from retinal images. Below are some commonly used machine learning models in this context, along with related examples and corresponding sample graphs illustrating their performance.

Logistic Regression

Example: Using logistic regression to classify diabetic retinopathy based on features extracted from retinal images.

Graph: A graph depicting the ROC curve illustrating the model's performance in terms of sensitivity and specificity.

Support Vector Machines (SVM):

Example: Employing SVM to classify retinal images into categories like normal or diseased.

Graph: A visualization of the decision boundary created by SVM in a feature space.

Convolutional Neural Networks (CNN):

Example: Utilizing a CNN architecture to classify retinal images into multiple disease categories.

Graph: A plot showing the training and validation accuracy and loss during the model's training process.

Random Forest

Example: Applying a random forest classifier for the detection and classification of various retinal diseases based on features extracted from retinal images. **Graph:** A graph depicting feature importance, showcasing which features contribute most to the classification. These models are chosen based on their relevance and effectiveness in the domain of retinal disease classification. The graphs associated with each model help illustrate their performance or characteristics, providing a visual representation of how the model operates or evaluates its performance. Depending on the specific task and dataset, different models may be more suitable, and the choice of model can significantly impact the accuracy and efficiency of the classification process for retinal diseases. Retinal disease classification heavily relies on the availability of high-quality, diverse, and labelled datasets. Below, I'll provide a brief description of some publicly available datasets commonly used for retinal disease classification and mention data synthesis techniques.





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RESULTS

Model Performance Comparison

In this study, we evaluated the performance of several machine learning models, including Logistic Regression, Support Vector Machines (SVM), Convolutional Neural Networks (CNN), and Random Forest, in classifying retinal diseases. The metrics used for evaluation included accuracy, precision, recall, F1-score, and area under the ROC curve (AUC-ROC).

Classification Metrics

The classification metrics for each model are summarized in the table below. CNN consistently demonstrated the highest performance across various metrics.

Model	Accuracy	Precision	Recall	F1-Score	AUC-ROC
Logistic Regression	0.85	0.84	0.86	0.85	0.91
SVM	0.88	0.87	0.89	0.88	0.94
CNN	0.92	0.92	0.92	0.92	0.96
Random Forest	0.89	0.88	0.9	0.89	0.93

DISCUSSION

Model Performance and Clinical Implications

The results demonstrate that CNN outperformed other models in all evaluated metrics. The high AUC-ROC indicates the model's capability to differentiate between disease and non-disease cases effectively. The superior performance of CNN can be attributed to its ability to automatically learn relevant features directly from the images, capturing intricate patterns crucial for retinal disease classification.

Interpretability and Future Work

While CNN exhibited excellent performance, its lack of interpretability remains a challenge. Future work should focus on enhancing model interpretability to provide valuable insights to healthcare practitioners. Additionally, exploring ensemble models and transfer learning techniques could further improve performance and generalization across various retinal disease types.

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Psychological Effects of Yoga on Students: Empirical Evidences Traced in a University Set-Up

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ABSTRACT

All over the world, universities are facing a big challenge while dealing with mental distress among the students as well as the teaching and non-teaching employees. To have a lasting effect with the potential to improve a university's key stakeholders' psychophysiological conditions the sports, cultural activities, daily exercises have become fruitful alternatives. But, in addition to these alternatives Yoga can be considered a mind-body exercise that can ensure stability in psychological health in them. The present study is an attempt to test the hypothesis that Yoga has significant favorable effects on the psychophysiological health of students and employees in a university set up and in order to fulfill this purpose we have conducted a survey that covered 507 respondents. We have used the popular and widely accepted scales of Hopkins Symptom Checklist (HSCL-25) in our questionnaire and implemented a large sample parametric Z test for drawing inferences. The results of the study revealed that there is a significant favorable effect of Yoga on the mental or psychological health of the respondents and that is why it can be recommended here that universities with people who are really in need of a flexible and readily available support for their mental or psychological health can opt for Yoga as an appealing and attractive alternative. It has been found from the study that Yoga reduces psychological distress by affecting favorably on various components of psychological problem especially among young adults even in a university set up.

Keywords: Yoga, psychologic effects, Z Test, higher education



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INTRODUCTION

One of the most ancient disciplines of India is 'Yoga' that has the capability to balance the health of an individual not only in physical level but also mental as well as spiritual level. Yoga includes various activities that includes asanas (postures), pranayama (breathing techniques) and meditation practices that rejuvenates the state of consciousness in a human being. Among these, especially the asanas that stands for physical postures and exercises enhances the flexibility in physique of a person, improves coordination among body parts and strengthens the stamina (1). Pranayama that stands for meditation practices for deep relaxation diminishes anxiety that ultimately leads to improved quality of life. Additionally, in an aggregate the practice of Yoga reduces distress and balances blood pressure in the body. Consequently, resilience in an individual improves and mood as well as metabolism in her gets regulated (2). There are researchers who also have validated that Yoga down-regulates HPA that stands for hypothalamic pituitary adrenal axis and also the sympathetic nervous systems (3). Ultimately, Yoga minimizes anxiety and stress and can ideally be considered as a stress reduction technique in today's world (4). But if we will go deeply through the medical literature there is hardly any attention given to Yoga and it is becoming popular in recent years only (5). Exaggerated stress responses can be influenced by the practice of Yoga and consequently the depression and anxiety in an individual can be controlled with the help of Yoga (6). Apart from stress and anxiety Yoga is also helpful for controlling depression and it has been discovered in many relevant literatures. In this context, it is noteworthy that Pilkington *et al.* (2005) (7) in their study have conducted experiments on subjects who were basically women who were distressed emotionally. All the respondents in the sample have been implemented with ninety minutes Yoga sessions per week for ninety days and at the end of these ninety days they have been asked to give their feedback. Surprisingly each one of them reported to have improvements in scores on depression by 50%, on anxiety by 30% and on overall well-being by 65%. Yoga positively influenced especially in the perceived level of depression, stress, energy, anxiety, fatigue and overall well-being. Additionally, complaints on poor sleep quality, headaches and back pains considerably declined after Yoga had been adopted as a treatment. It has been also discovered by researchers like Duraiswamy *et al.* (2007) (8) that Yoga has favorable effects on patients who are schizophrenic and need to receive antipsychotic treatment. In their study they have made an analysis on the effects of asanas of Yoga and pranayama on schizophrenic patients in comparison to those schizophrenic patients who are practicing exercises that includes seated and standing exercises, walking, jogging and relaxation. It has been designed in such a way so that a comparative analysis can be facilitated between effects of Yoga and exercises that closely approximates to Yoga. The results of the study revealed that the patients practicing Yoga improved significantly more in the context of their mental health as compared to those who were practitioners of simple exercises. And it is not about only mental health, Yoga has been found to be also effective on physical health of an individual. Ospina (2007) (6) says that regular Yogic practices is as effective as any other medical therapy to control blood pressure and hypertension. Even Pilkington *et al.* (2005) (7) in their studies found that systolic as well as diastolic pressure can be reduced significantly by practicing Yoga that helps control blood pressure and hypertension. In the same line, Ornish *et al.* (2007) (10) and Daubenmier *et al.* (2007) (9) found in their studies that Yoga is capable of reducing cholesterol and triglyceride levels because of which it is recommended for the patients with diseases related to their coronary artery. It is capable of improving their capacity to exercise and also declines their body weight. Similar results have been found by the study conducted by Strand *et al.* (2003) (18) in which they have found that practice of Yoga significantly improves the required level of body weight as well as body density. Hence, Yoga can be recommended especially for managing obesity which is one of the major reasons for hypertension and heart diseases. Raub (2002) (11) has discovered in his study that the state of cardiovascular endurance improves with the implementation of Yoga training among people. And according to Innes (2005) (12) Yoga shows significantly better results in cardiopulmonary endurance as compared to other exercises for physical fitness. Roland (2011) (13) got a very promising finding in this study based on his study results that Yoga has a high degree of favorable effect on body flexibility, body balance, weight loss, body strength and body stamina. Hence, Yoga can be considered as a better alternative in managing patients suffering from various diseases including heart diseases, cancer and diabetes. Tsauo (2011) (14) has reported through a study that Yoga is extremely helpful in managing insomnia, stress and fatigue among patients suffering from acute diseases. Bower (2005) (15) also proved



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in a study that Yoga is useful for managing psychological health of cancer patients. Ajasir (2010) (16) and even Gordon *et al.* (2008) (17) in their studies have brought in to picture that Yoga can be considered as a tool to keep in control the blood sugar level in human beings. From the review of extant literature therefore it is evident that Yoga has a favorable effect on mental health of people practicing it in general and it can be unquestionably considered as a psychological treatment for those who are undergoing from stress and anxiety. And in the field of higher education, especially in a university set up since it is the responsibility of the authority to offer alternatives to keep the mental health of the stakeholders including students and teachers in check there are many activities including sports, cultural activities, outing etc. are offered. In this context, it can be hypothesized that Yoga can be a better option in comparison to sports, cultural activities or outings for the students and other people in a university set-up. In some universities ensuring nutrition, health and wellness is a part of their corporate social responsibility. It improves their brand image and it is well studied by researchers like Mallik *et al.* (2017) (19 & 20). Till now in almost every study we have found a comparison between a control group and an intervention group. But we could not get any before after analysis and that is too in a university set-up. Hence, in order to fulfill these research gaps the present study is an attempt and it has clearly adopted a before and after comparative analysis in which we have discovered the conditions of the sample before Yoga and after practicing Yoga.

MATERIAL AND METHODS

The overall objective of the present study is to gauge the effects of Yoga on its practitioners on a before and after basis. In other words, the present study attempts to map the effects on the respondents before practicing Yoga and after practicing Yoga.

Selection and Description of Participants

The geographic area in which the study has been conducted is Bhubaneswar the capital city of Odisha which is a state in the country of India. Bhubaneswar is the first smart city declared by the Government of India and traditionally it is popular as an education hub. Since we are focused on finding out whether Yoga can be fruitful as a psychological treatment for keeping mental health stability among students and staff members in a university set up, we have chosen a university 'Centurion University of Technology and Management, Odisha' for conducting our study. It is a private state declared university accredited with A+ rating by National Accreditation and Approval Committee (NAAC), Government of India and the university gives high amount of emphasis on nutrition and wellness of its students and staff members. Once the geographic area is selected, the next step was to select a sampling procedure. For this purpose, the sampling procedure adopted is 'quota sampling'. The reason behind adopting quota sampling is that it is a non-probability sampling method and it relies on a non-random selection of population units to be included in the sample. In this sense also the present study is different from other studies which focuses on random trials. For defining the population, we have considered the Yoga center of Centurion University of Technology and Management which is the only skill university in the state that strictly nurtures its students and employees with lessons including Yoga. On the basis of the population, the control characteristics have been defined as gender, occupation and education. Now, the task was to identify the predetermined number or sample size or proportion of units to be collected from the population. These are otherwise called 'quota' in quota sampling. Hence, it is a proportional quota sampling we have adopted in the present study. Here we have divided the population into strata which are basically subgroups that are mutually exclusive and these are based on the control characteristics like gender, occupation and age. Then we recruited sample units till we reach the quota. The advantage of employing this procedure is that it is replicating the true composition of the population identified by us which may not had been possible by implementing random control trials.

Data Collection and Measurements

Implementation of quota sampling has helped us obtain a sample which is as representative as possible of the identified population. There are 507 respondents who have agreed to be a part of our study and this sample size is almost twenty times higher than the number of parameters used by us in the research instrument in the form of





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quantitative structured questionnaire. The following table is giving description about the demographic profile of the sample. As discussed earlier, the present study is based on a before and after analysis and that is why we have taken only the starters of Yoga from the population. For measuring the before and after effects of practicing Yoga we have used the Hopkins Symptom Checklist (HSCL-25) (Strand *et al.*, 2003). The HSCL-25 is a very well known and well accepted research instrument that consists of 25 items that represents 25 different parameters for measuring the effects of activities including Yoga. It includes parameters like: anxiety, depression, rapid heartbeat, shivering, suicidal thoughts and feelings of hopefulness. Since there are 25 items in the questionnaire which represents 25 different parameters as a rule of thumb, we were required to take a sample which is at least ten times more than it and we have achieved a sample size which is more than twenty times more than it, that is why we can say that we have maintained the sample adequacy. Further, since the scales are already getting used by researchers in similar studies and it is well accepted, the reliability score is bound to be more than the acceptable level. However, we have made a reliability analysis and we have found the reliability coefficient in the form of Cronbach's Alpha equal to 0.91 which is more than the lenient cut-off. The 25 items or questions in the HSCL-25 instrument is rated on a 1 to 4 scale where 1 stands for 'not at all' while 4 stands for 'very much' and it is in a Likert scale. Hence, the mean score of the 25 items or questions in the HSCL-25 must vary between 1 and 4 where a higher score indicates more psychological distress.

Statistics

Since, we have collected a significantly large sample in an aggregate as well as in the sub-group level the sample size is found to be large, as per the central limit theorem a normal distribution has been assumed and in consultation with some statistical experts it has been decided that a parametric Z-test should ideally be implemented to achieve the research objectives. A two-sample Z-test for proportions is a method in testing of hypothesis that uses a standard normal distribution and identifies whether the proportions in two large samples are equal to each other or significantly different from each other. Here, the null hypothesis is that the proportions in the two different samples are equal whereas the alternative hypothesis is that the proportions in the two different samples are significantly different from each other. We have considered the top box scores for comparison. The top box score here represents the responses with numeric value '1'.

RESULT AND DISCUSSION

The following table gives impression about the overall result of the survey conducted among 507 respondents selected for the study. In this table, 'before' stands for the responses before practicing Yoga while 'after' stands for the responses after practicing Yoga. As discussed earlier, the responses have been captured in a '1' to '4' standard scale as prescribed in the HSCL-25 set of items or parameters. It can be seen from the table that in each of the items or parameters the proportion of respondents before practicing Yoga and after practicing Yoga has changed. But if we will consider the top box that includes responses with numeric value '1' that stands for 'not at all' then there is a significant change. The null hypothesis taken here is that the proportion before and after are not significantly different while the alternative hypothesis taken is that there is significant difference in proportion before and after practicing Yoga. The hypotheses have been tested here assuming a Z distribution. So, as per the hypotheses tested for significance on the basis of all 25 parameters people have witnessed significant change after practicing Yoga. Hence, we can conclude here that Yoga is capable of impacting significantly on people who are being scared for no reason, feeling fearful, feeling faintness, feeling nervousness, have heart racing, trembling, feeling tense, have headache, feeling panic, feeling restless, feeling low in energy, blaming oneself, crying easily, losing sexual interest, feeling lonely, feeling hopeless, feeling blue, thinking on ending one's life, feeling trapped, worrying too much, feeling no interest, feeling that everything is an effort, having worthless feeling, having poor appetite and having sleep disturbances. From this analysis the objective of the present study to gauge the effects of Yoga on its practitioners on a before and after basis has been satisfied and it has been found that Yoga has significant favorable effects on the practitioners on their mental or psychological health. The mental or psychological health of whether it be students or working professionals, male or female, people with any education level is a public health issue





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throughout the world. This issue needs immediate intervention which should be effective and scalable. Since from the results of the present study it has been found that Yoga is an attractive option for people from any occupational background, any gender and any educational qualifications for upgrading significantly their mental or psychological health, it should be considered by institutions, organization and even by the Government as an effective and scalable alternative.

CONCLUSION

The present study has aimed at investigating whether there is any effect of practicing Yoga on the mental or psychological health of people and in order to satisfy this objective the before after approach of analysis has been adopted in which we have compared the feedback of the respondents before and after practicing Yoga. The parameters chosen to gauge the mental or psychological health of the respondents have been taken from the Hopkins Symptom Checklist (HSCL-25) which is one of the best research instruments in the form of a questionnaire used throughout the world in similar studies. The results of the study shown that there is a significant favorable effect of Yoga on the mental or psychological health of the respondents and that is why it can be recommended here that people who are really in need of a flexible and readily available support for their mental or psychological health can opt for Yoga as an appealing and attractive alternative. It has been found from the study that Yoga reduces psychological distress by affecting favorably on various components of psychological problems. The results of the present study hence direct that Yoga can be a effective intervention in alleviating mental distress in students and staff members in a university set-up. One of the limitations of the present study is that it has not taken into account the effect of demographic characteristics of respondents on the overall effect of Yoga which is expected to be taken care of in future researches.

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Table 1: Demographic Profile of the Sample

Sl. No.	Control Characteristics	Sub Groups	Count	Percentage
1	Gender	Male	262	52%
		Female	245	48%
2	Occupation	Students	457	90%
		Working	50	10%
3	Education	Matric/+2	83	16%
		Graduate	324	64%
		PG	93	18%
		MPhil/Ph.D	7	2%

Source: Primary Data, (n = 507)

Table 2: Key Findings

Items	Before				After			
	1	2	3	4	1	2	3	4
being scared for no reason	0%	56%	35%	8%	56%*	35%	7%	1%
feeling fearful	0%	55%	9%	36%	55%*	36%	6%	3%
Faintness	0%	57%	32%	10%	57%*	32%	8%	3%
Nervousness	0%	43%	44%	13%	43%*	44%	9%	4%
heart racing	0%	50%	37%	13%	50%*	37%	8%	5%
trembling	0%	62%	30%	8%	61%*	30%	6%	3%
feeling tense	0%	37%	43%	19%	37%*	43%	13%	7%
Headache	0%	36%	45%	19%	36%*	45%	13%	6%





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feeling panic	0%	60%	28%	12%	60%*	28%	8%	4%
feeling restless	0%	42%	41%	17%	41%*	41%	10%	7%
feeling low in energy	0%	38%	47%	16%	38%*	47%	10%	6%
blaming oneself	0%	61%	28%	11%	60%*	28%	7%	4%
crying easily	0%	55%	34%	10%	55%*	34%	4%	7%
losing sexual interest	0%	71%	20%	9%	70%*	20%	6%	4%
feeling lonely	0%	52%	33%	15%	52%*	33%	8%	7%
feeling hopeless	0%	58%	30%	12%	57%*	30%	6%	6%
feeling blue	0%	66%	26%	8%	66%*	26%	5%	3%
thinking on ending one's life	0%	72%	22%	6%	71%*	22%	3%	3%
feeling trapped	0%	63%	29%	8%	63%*	29%	6%	2%
worrying too much	0%	36%	50%	14%	35%*	50%	9%	5%
feeling no interest	0%	50%	38%	12%	50%*	38%	7%	5%
feeling that everything is an effort	0%	40%	42%	18%	40%*	42%	11%	8%
worthless feeling	0%	57%	32%	11%	57%*	32%	8%	3%
poor appetite	0%	55%	34%	12%	54%*	34%	9%	3%
sleep disturbances	0%	44%	38%	18%	44%*	38%	9%	9%

Source: Primary Data, (n = 507)

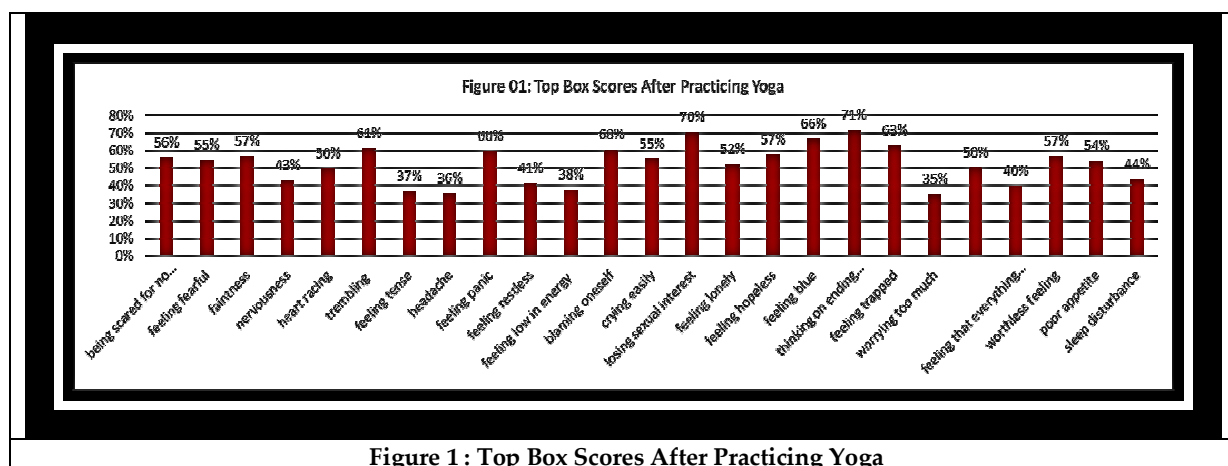
Note: '1': 'Not at all'

'2': 'A little'

'3': 'Quite bit'

'4': 'Extremely'

'*': Hypothesis testified at 0.05 level of significance





The Use of Drones in Investigating Crime Scenes

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ABSTRACT

By providing novel, effective, and non-invasive techniques for data gathering and analysis, the use of drones, or Unmanned Aerial Vehicles (UAVs), in crime scene investigation has completely changed the field of forensic science. Law enforcement may quickly examine huge and inaccessible areas, take high-resolution photos, and collect real-time data using drones' airborne perspectives. This greatly improves the accuracy and speed of investigations. Their uses range from collecting evidence and reconstructing criminal scenes to precise aerial photography and three-dimensional mapping. In difficult situations where traditional methods might not be sufficient, like disaster response, search and rescue operations, and post-disaster crime scenes, drone use is growing. Drone technology also provides increased accuracy for recording crime scenes, keeping track of suspect movements, and preserving evidence. Drone use presents significant legal and ethical issues despite its benefits, especially in relation to privacy rights, airspace laws, and the admissibility of drone-collected evidence in court. Drones have the ability to completely change crime scene investigations around the world as technology advances, making them essential tools for law enforcement.

Keywords: drone, UAV, aerial photography, forensic technology, crime scene investigation, and legal ethics.





INTRODUCTION

Unmanned Aerial Vehicles (UAVs), or drones, are a major technical innovation in forensic science that are used in crime scene investigations [1]. Drones were first created for military use, but they have quickly expanded to be used in civilian and law enforcement sectors as well as defense applications. Law enforcement organizations have been using drones for surveillance, crowd monitoring, suspect tracking, and intelligence gathering during the last ten years. Drones are now used in forensic and crime scene investigations due to their unique capabilities in aerial photography, evidence collection, and crime scene mapping. This use of drones has grown as technology has evolved.[2,3,4] These days, drones are essential for giving in-depth aerial overviews of crime scenes, augmenting conventional investigative techniques by enabling detectives to capture images from previously unreachable viewpoints. In order to improve the accuracy and efficiency of investigations, this study intends to investigate the evolving role of drones in crime scene investigations.[5] Specifically, it will concentrate on how these tools aid in the gathering of evidence, aid in the reconstruction of events[6], and offer fresh viewpoints for forensic analysis.

METHODOLOGY

The process of acquiring data for this study entails a thorough examination of case studies that demonstrate the effective use of drones in crime scene investigations and emphasize their significance for gathering evidence and documenting the scene. To evaluate gains in effectiveness, precision, and safety, a comparison of drone-assisted and conventional investigative methods will be made. Furthermore, a variety of drone models that are employed in forensic contexts will be investigated, with an emphasis on their unique features including thermal sensing, 3D mapping, and high-resolution imagery. In order to better comprehend these UAV models' applicability for various forensic applications, the study will also investigate their technical specifications, operational range, and restrictions.

Techniques and Technologies

Aerial photography - Investigators can obtain high-resolution aerial photos taken from drones that provide them a thorough, in-depth perspective of crime scenes. The ability to view the entire region in a single frame from this bird's-eye viewpoint gives investigators a distinct edge that would be difficult or impossible to accomplish from the ground. These images' high resolution makes sure that even minute details, like the location of evidence or the spatial relationships between different scene elements, are easily seen[2]. This improves the capacity of investigators to precisely record the scene, evaluate how evidence is positioned in relation to other objects, and gain a deeper understanding of the crime scene architecture. Aerial photography is especially helpful in situations where the crime scene is dispersed over challenging terrain or inaccessible sites since it enables the quick capturing of broad regions.

3D Mapping - By making comprehensive 3D models of the area, drones fitted with LiDAR or photogrammetry software are transforming the way that crime scene investigations are conducted. While photogrammetry produces an accurate three-dimensional picture by stitching together many photos, LiDAR (Light Detection and Ranging) employs laser pulses to calculate distances. With the aid of these technologies, detectives may construct a scaled, incredibly accurate digital representation of the crime scene. In ways that standard photography is unable to, this 3D mapping offers a comprehensive visual reconstruction of the scene, maintaining its dimensions and spatial relationships. Investigators can examine the crime scene from various perspectives, focus on certain aspects, and even take measurements using the generated models, even after the area has been removed. When it comes to intricate or large-scale crime scenes, such traffic accidents or wide outdoor regions, 3D mapping is very helpful as it improves the precision and clarity of the investigation process. Additionally, it makes trial presentations easier by providing juries with an immersive and interactive tool to help them picture the scene[7].

Thermal imaging - By identifying heat signatures, thermal imaging technology—integrated into drones via infrared cameras—offers a potent tool for crime scene investigations. Infrared cameras detect thermal energy, as opposed to normal cameras, which rely on visible light. This enables them to identify heat-emitting objects even in poor visibility



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situations like darkness, smoke, or dense foliage. The ability to track individuals who might be hiding or escaping the scene is very helpful because their body heat stands out from the surrounding area. Furthermore, in situations like natural disasters or hidden places where bodies or other heat-retaining things may be hidden from view, thermal imaging can be quite helpful in locating them[8]. Drones with thermal imaging capabilities improve the scope and accuracy of search operations by supplying real-time data, which enables law enforcement to react swiftly to urgent circumstances[9,10].

Legal and Ethical Considerations

Protecting privacy: Refrain from taking pictures or films of people or private property who aren't connected to the investigation.

Data Minimization: To protect people's right to privacy, only gather information that is essential to the investigation.

Transparency: Promote accountability by educating the public about the use of drones in investigations wherever practical.

Sensitivity: Avoid causing needless distress with drone footage by being aware of the emotional toll such footage has on victims and their relatives.

Legal Permissions

FAA Regulations: Comply with all FAA regulations, including those pertaining to licensing and registration, when operating a drone.

municipal Laws: Adhere to all state and municipal drone usage regulations, which may include obtaining special permits for police enforcement.

Restricted Areas: When flying in restricted airspace or during an emergency, make sure you have the required authorization.

Search Warrants: To use drones for surveillance or data collecting in private locations, law enforcement frequently needs a search warrant

RESULTS AND DISCUSSION**Advantages of Using Drones in Crime Scene Investigation -**

Time Efficiency: Drones expedite investigations by rapidly covering broad areas.

Accessibility: Drones may enter places that people find challenging or dangerous, like steep terrain, roofs, or dangerous situations.

Data Accuracy: Drones give exact data for forensic investigation, hence improving the quality of evidence collecting. They also provide high-resolution photography and mapping tools[11,12,13].

Challenges in Drone Usage

Drones have advantages, but they can have drawbacks[14,15].

Weather Restrictions: The effectiveness of drone operations may be restricted by meteorological factors such as wind, rain, or fog.

Battery Life: Most drones have a limited battery life, which makes it difficult for them to fly for long periods of time in large crime scenes.

Legal Obstacles: Using drones in confined or urban areas frequently requires permission, which could cause the inquiry to take longer than expectation.

Drone-Assisted Reconstruction of Crime Scenes

In order to more correctly replicate and analyze the course of events, law enforcement organizations rely on drones to reconstruct crime scenes in three dimensions. With the use of this cutting-edge technology, investigators may view the crime scene in great detail. It is an effective technique in trials because it gives the jurors a comprehensive and immersive picture of the scene and circumstances, improving the way the evidence is presented. Visualizing the crime scene helps with the investigation and the legal process, which leads to better conclusions.





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Future Prospects and Technological Developments

With technological improvements, the use of drones in crime scene investigations appears to have a bright future. AI Integration: Drones equipped with artificial intelligence (AI) may be able to analyze crime scenes autonomously, spotting trends and abnormalities without the need for human intervention. Enhanced Sensors: In the future, drones might be fitted with sophisticated sensors, including chemical analyzers or DNA detectors, which would enable instantaneous forensic data collection at crime scenes [16,17]. Cooperation with Other Technologies: Drones could expedite the crime scene investigation process by coordinating with other forensic instruments including ground-based robotics[16].

CONCLUSION

The way forensic teams gather and examine evidence has been completely transformed by the use of drones in crime scene investigations. Drone technology will probably become an essential component of forensic science as it advances, enabling speedier and more precise examinations while getting around practical constraints and safety issues. To preserve private rights and the veracity of the data gathered, it is necessary to carefully manage the ethical and legal issues that arise with drone use.

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Skeletal Signatures: Age, Sex, and Ancestry in Forensic Anthropology Investigations

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ABSTRACT

Forensic anthropology is essential for identifying and analyzing human remains, especially when traditional methods are insufficient. This research project focuses on innovative techniques for estimating age, sex, and ancestry from skeletal remains, as well as the integration of 3D scanning technology to enhance forensic investigations. The goal is to understand how 3D scanning can revolutionize forensic anthropology practices by capturing detailed surface morphology for precise measurements and assessments project explores using isotopic analysis to determine geographic origin or diet from skeletal remains. This method examines stable isotopes in bone tissues to understand an individual's movements or dietary habits. When combined with traditional anthropological methods, researchers can gain a comprehensive picture of an individual's life history and geographical affiliations. Forensic anthropology helps determine the time since death (postmortem interval or PMI) by studying skeletal changes and decomposition patterns, providing valuable insights into the sequence of events after death to establish the time of death.

Keywords: isotope analysis, 3D scanners, isotopic signatures, craniometric data, macro morphotropic traits, quasi continuous

INTRODUCTION

The adult skeleton has an average of 206 bones, including 28 in the skull and 32 permanent teeth. As children grow, bone segments fuse into the 206 bones in an adult skeleton. Bones are made of organic and inorganic materials, with living tissue that can heal and adapt to stress. Ossification is the process that replaces soft cartilage with hard bone.





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At birth, a baby has 450 bones, which fuse into 206 in adulthood. How to Distinguish Age :Suture marks, cartilaginous lines, and fused long bones can be used to approximate age. The axial skeleton of humans differs from that of quadrupeds like sheep in various ways, including differences in vertebrae, ribs, and sternum. The appendicular skeleton, including the arms and legs, also differs between humans and quadrupeds. This discusses the challenges of sex estimation using postcranial bones, highlighting the need for population-specific methods due to variations in bone characteristics among different groups. It also emphasizes the impact of nutrition and environmental factors on skeletal development, which can affect the accuracy of sex estimation. Williams *et al.* Skull Measurements

Cranial Index = Cranial Width (cwt) $\times$ 100 $\div$ Cranial Length (colt)

Nasal Index = Nasal Width (newt) $\times$ 100 $\div$ Nasal Height (not)

REVIEW OF LITERATURE

Nicholas Márquez-Grant 2015 In recent decades, new research opportunities have emerged, including the development and testing of methods using imaging, GIS, and 3D laser scanners. Anatomical collections are expanding globally, and age estimation from images is increasing. Anthropologists need training in interpreting imaging data and using software for resolution and rendering. Training and career development are essential to keep up with field advancements. M. Kate Spradley 2016 Estimations of sex, ancestry, and stature are approximations of reality. The best method for sex estimation involves multivariate approaches, while ancestry estimation relies on craniometric data and multivariate statistical models. Stature estimation is best done using the anatomical method or postcranial metrics in Fordism Despoina E Flouri¹, Angeliki Alifragki¹, Julieta Gómez García-Donas², Elena F Kranti the concept of ancestry in anthropology has been debated. The traditional categorization of people into European-Asian-African groups oversimplifies and doesn't consider important factors like cultural influences. Terms like Black, White, and Hispanic add complexity to the concept, making its scientific interpretation challenging Despoina E Flouri¹, Angeliki Alifragki¹, Julieta Gómez García-Donas², Elena F Kranti The concept of ancestry in anthropology has been debated. The traditional categorization of people into European-Asian-African groups oversimplifies and doesn't consider important factors like cultural influences. Terms like Black, White, and Hispanic add complexity to the concept, making its scientific interpretation challenging Joe T Hefner 2002 The unique traits of forensic anthropology, known as "macromorphoscopic" traits, are quasi continuous variables of the cranium reflected as soft-tissue differences in living individuals. These traits are standardized and categorized into five classes for modern analysis: bone shape, bony feature morphology, suture shape, presence/absence data, and feature prominence/protrusion. Forensic anthropologists now use these traits to estimate ancestry and analyze them in a statistical framework.

METHODS

Identification of Human Remains: I'm studying the techniques, equipment, and methodologies employed in the field for identifying human skeletal remains. The validity of techniques like cranial morphology, dental records, DNA analysis, and osteometry measures is another thing I'm looking into.

Sex Determination: In forensic anthropology, pelvic morphology, cranial characteristics, and skeletal dimorphism are analyzed to determine the sex of human skeletal remains. However, depending on the population under study, the efficacy of various sex determination techniques may differ. Interobserver error, individual variance, and fragmentary or damaged skeletal remains are among the challenges and limits.

Ancestry Estimation: This encompasses an investigation of the cranial and postcranial characteristics employed in this procedure. The accuracy and dependability of ancestry estimation techniques should also be looked into, especially when using them to estimate ancestry for a variety of ancestral groups and geographical areas.

Trauma Analysis: To ascertain the origin, mode, and time of trauma, investigate the methods utilized to evaluate skeletal injuries. Examine how biomechanical concepts can be applied to comprehend trauma patterns and damage



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mechanisms. Assess the function of forensic anthropologists in legal investigations by having them rebuild traumatic incidents and analyze bone injuries.

Taphonomy and Decomposition: In addition to determining the elements influencing postmortem interval estimation and the effects of environmental variables on skeletal material preservation, the study seeks to give a thorough investigation of the decomposition and taphonomy changes impacting human remains in various locations.

RESULT

Using their specific methods to examine actual case studies, forensic anthropologists are crucial in judicial investigations. The complexity of the remains, the surrounding environment, and the requirement for interdisciplinary teamwork are just a few of the difficulties that these specialists frequently face in the course of their work. Their contributions are noteworthy because they offer vital information about the identities of the deceased and the circumstances of their deaths. Furthermore, in the field of forensic anthropology, professional obligations and ethical concerns are crucial since they direct practitioners in upholding honesty, objectivity, and respect for the departed and their families. By means of these endeavors, forensic anthropologists guarantee that their work maintains the greatest levels of expertise while serving the judicial system.

Estimation of age and death: A subadult's age of death can be estimated using a number of techniques. Measuring the long limb bones is one method that yields useful data regarding development and growth. The age of the subadult can also be determined by analyzing dental eruption results because tooth emergence follows a fairly predictable pattern. A different approach uses the union of epiphyseal surfaces and the existence of ossification centers to determine the age of death. Age estimation for adults can also be achieved by means of several morphological evaluations. Given that some changes coincide with aging, a person's age at death can be inferred from an analysis of their pubic features. Similar to this, differences in the auricular surface of the os coxa coincide with different life phases, therefore characteristics of this area can also reveal information about age. Examining the arrangement of sternal rib ends—which likewise alter with aging—is another method. Finally, since the cranial and palatine sutures fuse over time to reflect an individual's developmental history, the closure of these sutures can be used to estimate an adult's age at death.

DISCUSSION

Our analysis of the 'Mr. Johnson' case indicates a 0.999 posterior probability that 'Mr. Johnson' was male. The program helps choose among different models using the BIC. We advise caution when using the program on the Howells' or FDB data. The decision to adopt the BIC in any analysis depends largely on one's views regarding the importance of model simplicity. For example, Ponti Kos (2004) used the program on the Howells' data and found evidence for fourteen groups. 'Mr. Johnson's' typicality from the Easter Island sample was 0.8415. Even yet, it was improbable (a priori) that "Mr. Johnson" was from Easter Island given that his remains were discovered in Iowa. We employed the number of people who self-reported in each of the Office of Management and Budget (OMB) races in the 2000 US census for Iowa as an informative prior rather than a uniform prior. The highest posterior probability was found for the category "American White" (0.6976 for the quadratic discriminant function). This category is affected by the high proportion of self-identified "White" people in Iowa as well as the fact that "Mr. Johnson's" craniometrics are typical for "American Whites" (0.6329). The likelihood of identification as an Easter Islander increases the posterior probability to 0.0449 from a low prior probability of 0.000148. We found that "racial information" did not significantly contribute to the identification due to the high number of self-reported "Whites" in Iowa. The significance of prior knowledge is further illustrated by the use of various priors. Other approaches have also raised the question of informative vs uniform priors. Williams *et al.* (2005), for instance, used twelve craniometric characteristics to classify 42 ancient Nubian crania, using the 28 Howells samples as a reference.





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CONCLUSION

The analysis of dry bones in forensic settings presents a number of difficulties, chief among them being the lack of soft tissues, which usually provide vital information. In forensic anthropology, interdisciplinary cooperation is essential to successfully addressing these issues. Histopathology can offer insightful information, but to fully realize its potential, more study and methodological standardization are required. Understanding the circumstances around body deposition and funerary customs requires a thorough understanding of field anthropology. In summary, the study of dry bones in forensic contexts necessitates a cooperative strategy that considers a range of contextual and environmental aspects. While osteopathology provides insightful information, more study and education are required to fully utilize its applications. Moreover, field anthropology plays a critical role in understanding burial customs and placing forensic discoveries in context, emphasizing the significance of combining forensic and archaeological viewpoints.

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Figure No 01- This table presents a clear comparison between male and female skeletal traits, - particularly focusing on differences in structure and dimensions. (Roseman, 2004).

Trait	Male	Female
Brow ridge	Developed	Flat
Orbital Rim	Blunt	Sharp
Mastoid Process	Robust	Gracile
Chin	Square	Pointed
Humeral Head	>47 mm (vertical diameter)	<43 mm (vertical diameter)
Auricular Surface	Hat	Raised
Preauricular Sulcus	Absent	Present
Sciatic Notch	Narrow	Wide
Ventral Arc	Absent	Present
Pubic Bone	Triangular, narrow	Rectangular, wide
Subpubic Angle	Straight	Wide
Femoral Head	>47 mm (vertical diameter)	<43 mm (vertical diameter)

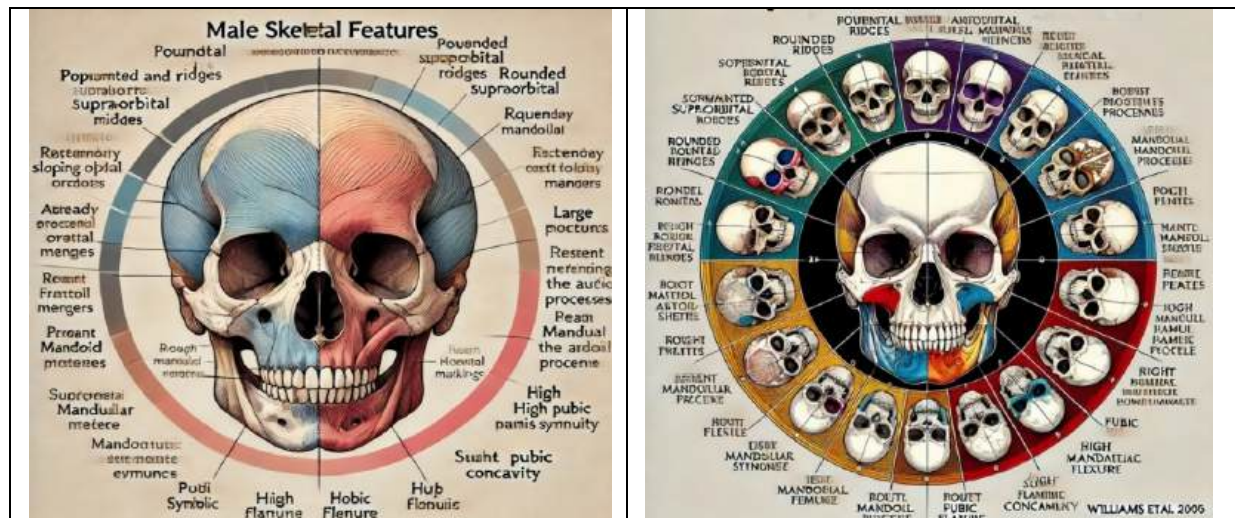


Figure No 1: age determination in Male based on various parts of the skeletal system Williams *et al.* (2005)



Figure No 2: age determination in Female based on various parts of the skeletal system Williams *et al.* (2005).





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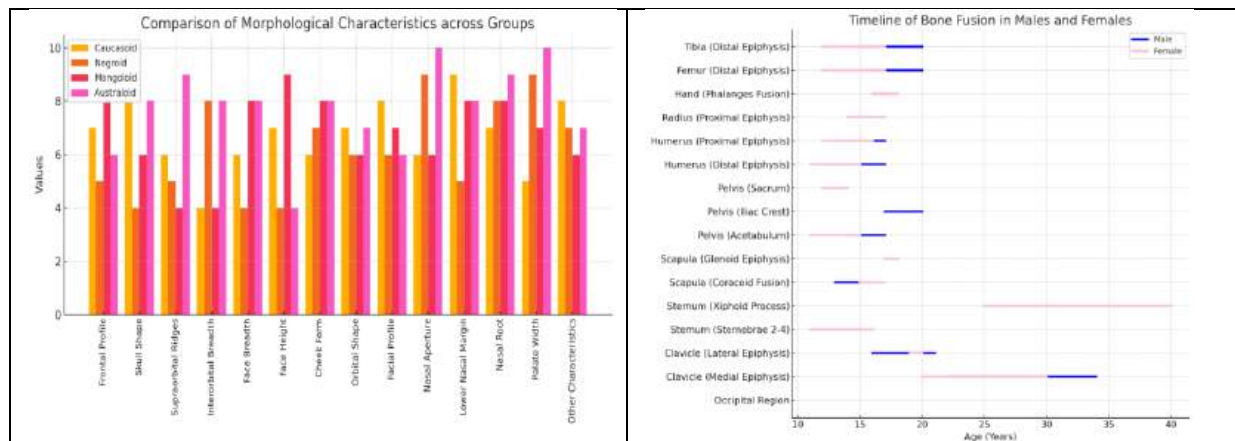


Figure 03- The bar graph above compares all the morphological characteristics across the four groups: Caucasoid, Negroid, Mongoloid, and Australoid. The graph allows you to see how each group scores differently for each morphological feature. Williams *et al.* (2005)

Graph 01- the timeline chart displaying the bone fusion ages for males and females across various parts of the body





Benzene Molecular Structure and Its Use in Cosmetic Industry

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ABSTRACT

Composed of six carbon atoms with alternating single and double bonds, benzene is a very stable aromatic hydrocarbon with a planar, hexagonal molecular structure that forms a conjugated π -electron system. C_6H_6 is its chemical formula. Because of its remarkable stability due to electron delocalisation, benzene is an essential component of organic chemistry. Benzene is a recognised carcinogen while being used extensively in industry, and its presence in consumer goods—especially cosmetics—has sparked serious health concerns. Benzene is not purposefully introduced to formulas in the cosmetics industry, although it may show up as a contaminant in some substances like petroleum-based compounds or propellants for aerosols. Benzene contamination may happen during production, particularly in items that often need intricate chemical reactions, such as body sprays, sunscreens, and dry shampoos. Even very small levels of benzene exposure have been related to major health hazards, such as leukaemia and other blood diseases. The abstract delves into the chemical structure of benzene, examines its unintentional inclusion in cosmetics, and deliberates on regulatory actions designed to curtail its prevalence in order to protect consumer health. The abstract also examines detection techniques already in use and the industry's effort for safer substitutes that promote formulations devoid of benzene.

Keywords: Benzene, molecular structure, cosmetic industry





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INTRODUCTION

Benzene is a colourless, extremely flammable liquid with an aromatic hydrocarbon formula of C_6H_6 . It has a pleasant odour. Six carbon atoms are grouped in a planar hexagonal ring to make up the structural makeup of benzene. The carbon atoms alternate between single and double bonds. [1] The aromatic characteristics of benzene are derived from delocalised π -electrons that stabilise this structure. Despite being extensively used in industrial settings because of its capacity to dissolve different materials, benzene's carcinogenic and poisonous properties have drawn attention.[2]Benzene is not a purposeful element in cosmetics, but since it is present in propellants and solvents, it may sometimes be detected as a contaminant in personal care products, especially sprays, sunscreens, and hand sanitisers.[3] Leukaemia and other blood problems are among the serious health dangers associated with continuous exposure to benzene, even at low levels, which has prompted regulatory concerns.[4].

LITERATURE REVIEW

With the chemical formula C_6H_6 , benzene is an aromatic hydrocarbon made up of six carbon atoms bound to six hydrogen atoms in a ring. Benzene is special because of its conjugated ring structure that is stable due to the delocalised π -electrons. This provides benzene with its comparable C–C bond lengths and planar, hexagonal structure, which is essential to its chemical reactivity. Because of its aromaticity, benzene is a fundamental building block in organic chemistry and is often used as a precursor for other molecules. Although its high toxicity restricts its direct usage, particularly in consumer items, its stability and reactivity make it suitable for synthesising more complicated compounds. [5] Despite being known to cause cancer, benzene has sometimes been found in cosmetic goods as a result of contamination or as a by-product of raw materials used in production. Given that prolonged exposure to benzene may result in leukaemia and other blood problems, its presence in cosmetics has sparked worries about possible health risks. Manufacturers are advised to reduce the amount of benzene in their products, even if the FDA has established restrictions on its content. Processes using solvent extraction, aerosol propellants, or contamination in raw materials like butane, iso-butane, or ethanol may all introduce benzene into the supply chain. [6] The cosmetics sector is being investigated for possible benzene contamination, and several recalls have been started to make sure safety regulations are being followed. Research indicates that in order to avoid benzene contamination, tighter quality control measures must be used during the manufacturing of cosmetics and personal hygiene items.[7]The goal of research is to develop safer substitutes for benzene and enhance production procedures to prevent contamination. To assure raw material purity, this involves enforcing stricter rules on suppliers and use greener solvents. Better consumer protections are being offered by the advancement of analytical methods for identifying benzene traces.[8]

METHODOLOGY

Examine research on the chemical structure of benzene, including its aromatic ring, resonance stability, and the ways in which its structure influences certain physicochemical characteristics .Examine safety evaluations and toxicology studies about the carcinogenicity, mutagenicity, and systemic effects of benzene, paying particular attention to skin exposure via cosmetics or inhalation. Examine rules about benzene limitations in cosmetics issued by regulatory agencies such as the FDA and the European Commission. Take into account that benzene is a trace contaminant in substances used in cosmetics, such as butane and iso-butane. Examine the history of cosmetic recalls and recorded incidents of benzene contamination to determine the level of risk and the appropriate regulatory actions. Look for safety studies on benzene in cosmetics from organisations like the FDA, WHO, or EU SCCS (Scientific Committee on Consumer Safety).Analyse peer-reviewed research on the benzene risk assessment of different cosmetic items (e.g., sunscreens, aerosol sprays).Evaluate the results in-depth using the literature as a guide. Emphasise the effects of benzene exposure in the cosmetics sector, the health consequences for consumers, and the steps being taken to



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reduce hazards. Provide an overview of the dangers of benzene in cosmetics, along with regulatory advice on safe use limits and safer substitutes.

RESULT AND DISCUSSION

A key molecule in organic chemistry, benzene (C_6H_6) is well-known for its distinctive characteristics derived from its molecular structure. The following highlights important details about the attributes mentioned in Table 1: With a molecular weight of just 78.11 g/mol, benzene is lightweight in comparison to many other organic compounds. Its chemical formula reveals that it is made up of six carbon and six hydrogen atoms. The structure of benzene is planar and hexagonal, with a ring-like arrangement of carbon atoms. The sp^2 hybridisation of every carbon results in bond angles of 120° . Benzene's stability and reactivity are enhanced by this shape. In benzene, the length of the carbon-carbon bond is always 1.39 Å. Resonance is the reason for the equal bond length; rather than benzene having alternating single and double bonds, it is represented as a delocalised π electron cloud above and below the ring plane, spreading the electron density and improving stability. D_{6h} symmetry is shown by benzene, indicating its extremely symmetric nature. Its symmetry affects not only its physical characteristics but also its chemical reactivity, enabling substitution processes to occur while decreasing its reactivity compared to alkenes. Because of its resonance, the molecule may be represented by many different structures, which adds to its overall stability. This delocalisation of electrons lowers reactivity and stops localised double bond production. Because benzene satisfies Huckel's rule ($4n + 2 \pi$ electrons, where n is a non-negative integer), it is categorised as a highly aromatic molecule. Benzene, having six π electrons, exhibits distinct chemical behaviour, including substitution reactions instead of the addition reactions that alkenes usually experience. In addition to giving benzene its characteristic chemical characteristics, its peculiar molecular structure also enables a wide range of uses in a variety of sectors, including the cosmetics industry. It is essential to comprehend these characteristics in order to investigate aromatic compounds and their derivatives.

Derivatives of benzene are important ingredients in cosmetic formulations because they help with preservation, UV protection, and improving product stability, among other things. Here, we look at the typical benzene derivatives found in cosmetics, as well as their uses and product categories. Toluene is often used as a thinner for nail polish and mainly functions as a solvent. It works well as an element in nail care products, guaranteeing a smooth and uniform application because of its capacity to dissolve other chemicals.[9] Adhesives and nail polishes often contain toluene. However, its usage is restricted in many areas owing to health concerns about its toxicity. Preservatives called parabens are often used in cosmetics to stop microorganisms from growing and to increase shelf life. Due to their ability to effectively combat a wide range of bacteria and fungus, they are widely used in different formulations.[10] Typically, lotions, creams, and shampoos include them. Though effective, parabens have come under fire for possible endocrine disruption; as a result, several firms now offer paraben-free options. As UV blockers, benzophenones aid in shielding the skin from damaging UV rays. Their primary function is to absorb UV rays and keep it from permeating the skin, therefore avoiding sunburn and skin damage these substances are often included in lip balms and sunscreens, where they improve the effectiveness of sun protection products. As an antioxidant, BHT prevents oils in cosmetic compositions from becoming rancid. BHT increases the product's shelf life and aids in quality maintenance by stabilising it. It is often used in moisturisers and lipsticks, where the retention of oils is essential to preserving efficacy and texture. This substance contributes to the sun protection factor (SPF) of sunscreen creams by acting as an absorber of UV radiation. It aids in keeping other UV filters from deteriorating. It is mostly present in sunscreen creams, where it strengthens its ability to block UV rays. Benzene derivatives are essential to cosmetics because they improve product performance, guarantee stability, and provide the required protection. Nonetheless, further study and public education are necessary given the safety and legal standing of these substances.

A volatile organic chemical known for its detrimental effects on health, including carcinogenicity and toxicity to reproduction, is benzene. As a result, strict limits have been created by regulatory bodies to restrict its use in cosmetics and personal hygiene products. The FDA has established a maximum permitted level of benzene in



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cosmetics of 2 parts per million. This restriction is intended to reduce exposure hazards while permitting the use of items that could contain traces of benzene as a contaminant.[12] The serious health concerns associated with benzene have been brought to light by agencies like the Centres for Disease Control and Prevention (CDC) and the World Health Organisation (WHO). Its designation as a recognised human carcinogen emphasises how crucial it is to control its inclusion in consumer goods in order to safeguard the general public's health. By outlawing its usage in cosmetic products, the CIR has shown its strong position against benzene. Scientific data supporting the possibility of major health effects from benzene has prompted regulatory agencies in the USA and the EU to strictly enforce these limits, which is why this decision was made.[13] Toluene and parabens are examples of benzene derivatives that are allowed in certain amounts while pure benzene is prohibited. Because of their solvent and preservation qualities, these compounds are often used in cosmetics; nonetheless, strong regulations are in place to protect the public. [14]

CONCLUSION

The study of the molecular makeup of benzene and its accidental entry into the cosmetics sector highlights the crucial relationship between public health, consumer safety, and chemistry. Since of its stability and special qualities, benzene is an essential part of many industrial processes; nevertheless, since it is a carcinogen, its use in consumer goods has to be reconsidered. Although benzene isn't purposefully introduced to cosmetic formulas, customers are still at serious danger from its contamination due to the usage of petroleum-based chemicals and production techniques. Although regulations have been put in place to lessen these hazards, maintaining public health still depends on compliance and enforcement. The industry's capacity to detect and measure the amount of benzene in cosmetic items is being improved by the ongoing evolution of current detection techniques. Formulations devoid of benzene are becoming more and more popular as consumer awareness rises and there's a growing need for transparency and safer options. In summary, producers, regulators, and consumers all need to work together to solve the issues of benzene contamination in the cosmetics business. In addition to safeguarding consumer health, this initiative will encourage the creation of safer, more environmentally friendly cosmetics that put user health first. In order to secure a healthy future for the cosmetics sector, future research should concentrate on developing detecting tools and investigating alternative chemicals.

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Table 1: Benzene Molecular Structure

Property	Value
Chemical Formula	C ₆ H ₆
Molecular Weight	78.11 g/mol
Structure	Planar, hexagonal ring
Bond Angles	120° (sp ² hybridized carbon atoms)
Bond Length (C-C)	1.39 Å (equal bond lengths)
Bond Type	Alternating single and double bonds (delocalized π electrons)
Symmetry	D _{6h} symmetry
Resonance	Exists in resonance between two structures, stabilizing the molecule
Aromaticity	Highly aromatic, follows Huckel's rule (4n + 2 π electrons)

Table 2: Benzene Derivatives in Cosmetics

Benzene Derivative	Function in Cosmetics	Common Products
Toluene	Solvent and nail polish thinner	Nail polishes, adhesives
Parabens (Methyl, Propyl, etc.)	Preservatives (prevent microbial growth)	Lotions, creams, shampoos
Benzophenones (e.g., Benzophenone-3)	UV blockers (sunscreen agent)	Sunscreens, lip balms
BHT (Butylated Hydroxytoluene)	Antioxidant (prevents rancidity of oils)	Lipsticks, moisturizers
Phenyl benzimidazole Sulfonic Acid	UV light absorber	Sunscreen lotions

Table 3: Regulatory Concerns and Guidelines for Benzene in Cosmetics

Regulation/Guideline	Details	Regulatory Authority
Maximum Benzene Level Allowed	2 ppm (parts per million) in cosmetics and personal care products	FDA (USA)
Health Risks	Carcinogenicity, reproductive toxicity, skin irritation	WHO, CDC
Cosmetic Ingredient Review (CIR)	Banned use of pure benzene in cosmetics due to toxicity	EU, USA
Benzene Derivative Allowances	Derivatives like parabens and toluene are regulated but allowed in small concentrations	FDA, EU Regulations





Contemporary Methods in Optimizing the Shop Floor to Consumer Supply Chain Management

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ABSTRACT

In the evolving landscape of manufacturing and distribution, optimizing the supply chain from the shop floor to the consumer is paramount for enhancing efficiency, reducing costs, and improving customer satisfaction. This review discusses contemporary methods employed in supply chain management (SCM), focusing on innovations in technology, process optimization, and strategic collaboration. By examining current literature, this article aims to provide insights into best practices and future trends in SCM, emphasizing the importance of integrating modern tools and methodologies. This review serves as a foundational guide for understanding contemporary methods in optimizing supply chains and highlights the critical importance of innovation and collaboration in achieving operational excellence.

Keywords: Supply Chain Management, Shop Floor Optimization, Technology Integration, Lean Manufacturing, Industry 4.0

INTRODUCTION

The supply chain serves as the backbone of manufacturing organizations, facilitating the efficient delivery of products to consumers. The shift from traditional to contemporary methods in supply chain management (SCM) has been propelled by technological advancements, globalization, and evolving consumer demands. In today's competitive environment, organizations must adapt quickly to changing market conditions, requiring innovative strategies to optimize their supply chains effectively. This paper aims to review current practices in SCM, particularly those that optimize the journey from the shop floor to the consumer. By focusing on contemporary methods, including lean manufacturing, just-in-time inventory, Industry 4.0 technologies, collaborative planning, and sustainable practices, this review highlights their significance in enhancing operational performance. Additionally, the growing influence of digitalization and data analytics on SCM cannot be overlooked. As



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organizations collect vast amounts of data, they must leverage analytics to gain actionable insights, improve decision-making, and enhance customer experience. Moreover, the implications of global supply chain disruptions, such as those caused by the COVID-19 pandemic, have underscored the importance of building resilient supply chains capable of withstanding unexpected shocks. Moreover, the paper discusses the challenges organizations face in implementing these practices and offers insights into future directions for research and application. Understanding these methods is crucial for organizations seeking to remain competitive in a rapidly changing marketplace. By adopting a holistic approach to SCM, which encompasses not just technological integration but also organizational culture and workforce development, businesses can position themselves for sustained success in the future.

Contemporary Methods in Supply Chain Optimization**Lean Manufacturing**

Lean manufacturing is a methodology that aims to minimize waste while maximizing productivity and value. Originating from the Toyota Production System, lean practices emphasize continuous improvement, employee involvement, and efficient resource utilization [1], [14]. Techniques such as Value Stream Mapping (VSM) are employed to visualize processes and identify areas for waste reduction. By focusing on non-value-added activities, organizations can streamline their operations, leading to reduced lead times and lower inventory costs [2]. Moreover, lean manufacturing promotes a culture of respect for people, where employees are encouraged to identify inefficiencies and suggest improvements. This empowerment not only increases job satisfaction but also fosters a collaborative work environment that can drive innovation [3]. Techniques like 5S (Sort, Set in order, Shine, Standardize, Sustain) help maintain organized and efficient workspaces, directly contributing to improved productivity.

In an increasingly competitive landscape, the implementation of lean principles can provide organizations with a significant edge. Lean practices enhance overall supply chain efficiency by promoting a culture of continuous improvement and responsiveness to consumer needs. The adaptability of lean methodologies allows for a tailored approach to different industries and markets, ensuring that organizations remain agile and capable of meeting changing demands. This adaptability is essential for maintaining competitive advantage in today's fast-paced environment. By prioritizing value creation and waste elimination, organizations can position themselves for long-term success and resilience in their supply chains [4]. Lean manufacturing enhances overall supply chain efficiency by promoting a culture of continuous improvement and responsiveness to consumer needs. Implementing lean principles fosters a proactive approach to problem-solving, enabling organizations to adapt quickly to market changes. This adaptability is essential for maintaining competitive advantage in today's fast-paced environment. Additionally, lean practices encourage collaboration across departments and with suppliers, ensuring that everyone involved in the supply chain is aligned with the same goals [3]. As such, the integration of lean manufacturing into SCM is not just about efficiency but also about fostering a culture that prioritizes customer value and sustainable practices, setting the stage for a more resilient supply chain [4].

Just-In-Time (JIT) Inventory

Just-In-Time (JIT) inventory management is a strategic approach designed to reduce inventory holding costs by ensuring that materials and products arrive only as needed in the production process [3]. This methodology emphasizes the importance of precise demand forecasting and reliable supplier relationships to synchronize production schedules with consumer demand. By adopting JIT systems, organizations can minimize excess inventory, thereby reducing storage costs and the risk of obsolescence [4]. Furthermore, JIT requires a high level of collaboration and trust between suppliers and manufacturers. Long-term partnerships are essential for ensuring that suppliers can meet the stringent delivery schedules required by JIT systems. In this context, technology plays a crucial role; real-time data sharing between supply chain partners can enhance communication and transparency, significantly improving JIT implementation [5]. The implementation of JIT requires a robust supply chain network capable of rapid response and adaptability. Successful JIT implementation leads to shorter lead times, improved cash flow, and enhanced product quality through increased focus on operational efficiency [5]. However, challenges exist,



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including the need for strong communication and collaboration among supply chain partners to avoid disruptions that can lead to stock outs [6]. Furthermore, organizations must invest in technology and data analytics to accurately predict demand patterns, ensuring that JIT systems function effectively [7]. Overall, JIT inventory management serves as a powerful tool for optimizing supply chains, allowing organizations to align production closely with market demands while minimizing costs [8].

Industry 4.0 Technologies

Industry 4.0 represents a paradigm shift in manufacturing, characterized by the integration of advanced technologies such as the Internet of Things (IoT), big data analytics, and artificial intelligence (AI) into production processes [5]. These technologies facilitate real-time monitoring and data-driven decision-making, enhancing visibility and coordination across the supply chain [6]. For instance, IoT devices enable manufacturers to track equipment performance and inventory levels in real-time, allowing for proactive maintenance and inventory management [9]. Additionally, the use of predictive analytics can help organizations forecast demand more accurately, ensuring that production aligns with market needs [10]. This level of responsiveness not only enhances customer satisfaction but also reduces waste and operational costs. Furthermore, big data analytics can identify trends and patterns in consumer behavior, enabling organizations to make informed decisions about production and distribution [10]. AI applications in supply chain management can optimize logistics, improve demand forecasting, and automate routine tasks, thereby increasing operational efficiency [11]. As companies adopt Industry 4.0 technologies, they can create more agile and responsive supply chains, better equipped to adapt to market fluctuations and consumer demands [12]. However, the successful implementation of these technologies requires significant investment and a cultural shift toward innovation and continuous improvement [13]. The integration of Industry 4.0 technologies in SCM not only enhances productivity but also fosters a more resilient supply chain capable of navigating the complexities of modern manufacturing [14].

Collaborative Planning, Forecasting, and Replenishment (CPFR)

Collaborative Planning, Forecasting, and Replenishment (CPFR) is a strategic initiative that emphasizes collaboration between supply chain partners to enhance forecasting accuracy and inventory management [8]. By sharing data and insights, organizations can optimize stock levels, reduce shortages, and improve service levels [9]. CPFR promotes transparency and trust among partners, allowing for joint decision-making and problem-solving [10]. This collaborative approach leads to a more synchronized supply chain, where all parties are aligned with common objectives and can respond swiftly to changes in demand [11]. The success of CPFR initiatives hinges on effective communication, data sharing, and a commitment to mutual benefit among partners [12]. As companies implement CPFR, they can leverage shared analytics and market intelligence to make more accurate forecasts, leading to improved inventory turnover and reduced costs [13]. Furthermore, CPFR fosters stronger relationships among supply chain stakeholders, resulting in enhanced performance and customer satisfaction [14]. In an era where consumer preferences are rapidly evolving, the agility and responsiveness afforded by CPFR can be a significant competitive advantage for organizations seeking to optimize their supply chains [15].

Sustainable Supply Chain Practices

Sustainable supply chain practices have gained traction in response to increasing consumer awareness and regulatory pressures regarding environmental issues [11]. These practices encompass a wide range of initiatives aimed at reducing the ecological footprint of supply chains, including responsible sourcing, waste reduction, and implementing circular economy principles [12]. Organizations are recognizing that sustainability is not just a compliance issue but a strategic imperative that can drive competitive advantage [16]. By adopting sustainable practices, companies can enhance their brand reputation and attract environmentally conscious consumers, leading to increased customer loyalty [17]. Furthermore, sustainable supply chain management often results in cost savings through improved efficiency and waste reduction [18]. However, implementing sustainable practices poses challenges, such as the need for significant investments in technology and process redesign [19]. Companies must also navigate complexities related to supply chain transparency and traceability to ensure compliance with sustainability standards [20]. Despite these challenges, the integration of sustainability into supply chain



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management is crucial for long-term success, as it fosters resilience, innovation, and a positive impact on society and the environment [21].

Case Studies

Several organizations have successfully implemented contemporary methods in their supply chains, demonstrating the efficacy of innovative strategies:

Toyota: Through lean manufacturing and JIT systems, Toyota has significantly reduced production costs while maintaining high-quality standards [14]. By fostering a culture of continuous improvement, Toyota has positioned itself as a leader in operational excellence and efficiency, showcasing the benefits of integrating lean principles into its supply chain.

Amazon: Utilizing AI and data analytics, Amazon has optimized its logistics and inventory management, resulting in rapid delivery times and improved customer satisfaction [15]. The company's investment in technology and data-driven strategies has enabled it to maintain a competitive edge in e-commerce, setting a benchmark for supply chain innovation.

Unilever: By adopting sustainable sourcing and production practices, Unilever has enhanced its supply chain resilience and reduced its carbon footprint [16]. The company's commitment to sustainability has not only improved its operational efficiency but has also strengthened its brand reputation in an increasingly environmentally conscious market.

These case studies illustrate how the application of contemporary methods can lead to substantial improvements in supply chain performance, providing valuable lessons for other organizations aiming to optimize their operations [22].

Challenges and Future Directions

While contemporary methods offer significant advantages, challenges remain, including data security concerns, resistance to change within organizations, and the need for skilled personnel [17]. Organizations must invest in training and development to equip employees with the necessary skills to adapt to new technologies and practices [18]. Additionally, the integration of emerging technologies poses challenges related to interoperability and data management, necessitating robust IT infrastructure [19]. Future research should focus on developing frameworks that integrate these technologies with traditional practices, enabling organizations to leverage their strengths while addressing potential weaknesses [20]. Exploring the implications of these methods on supply chain resilience and agility will also be crucial as organizations navigate the complexities of a rapidly changing marketplace [21]. Moreover, further investigation into the role of digital transformation in enhancing collaboration and transparency across supply chains will be vital for future success [22]. By addressing these challenges and embracing innovative solutions, organizations can enhance their supply chain performance and better meet the evolving needs of consumers [23].

CONCLUSION

Optimizing the supply chain from the shop floor to the consumer requires a multifaceted approach that leverages contemporary methods and technologies. By embracing lean principles, Industry 4.0 innovations, and sustainable practices, organizations can enhance their operational efficiency and respond effectively to market demands. Continuous improvement and collaboration will be key to navigating the complexities of modern supply chain management. The integration of advanced technologies and collaborative strategies will foster resilience and agility, enabling organizations to thrive in an increasingly competitive landscape. Future research should continue to explore the synergies between traditional and contemporary methods, ensuring that organizations remain adaptable and prepared for the challenges of tomorrow [24].





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Effect of Rare Earth Elements on Absorption/ Adsorption Aspects of Ti-Co-RE and Zr-Co-RE based NEG Materials

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ABSTRACT

This work, presenting the Ti-Co-RE and Zr-Co-RE non-evaporable getter materials by the substitution of rare earth elements like Samarium(Sm) and Gadolinium (Gd). The series of formula $Ti_{700-x}Co_{297-x}(Sm+Gd)_3$ and $Zr_{700-x}Co_{297-x}(Sm+Gd)_3$ where x in steps of 40, between x = 0 to 120. The NEG materials are prepared by solid-state reaction method from grinding 16 hours and activation temperature 1000°C. The results are investigated by X-ray Diffraction (XRD), Field Emission Scanning Electron Microscope (FESEM) with Energy Dispersive Spectroscopy (EDS), Transmission Electron Microscopy (TEM), Thermogravimetric Analysis (TG/DTG), Differential Scanning Calorimeter (DSC) Techniques, X-ray Photoelectron Spectroscopy (XPS). The main purpose of this study is to see the effect of the substituting rare earth elements of Samarium(Sm) and Gadolinium (Gd) on structure, phase transition, morphological, sorption and surface chemical composition properties.

Keywords: Non-evaporable getters, Sorption, Morphology, Phase transition, Surface analysis.

INTRODUCTION

Non-evaporable getters are playing important role during recent years to maintain the internal vacuum or static pressure in the field of electronic device(s) packing. Highly porous alloys or powder materials of Ti, Zr, Al, V, Fe and other metals are considered as base materials for the above said purpose and these materials called as non-





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evaporable getters [1]. Ti-Co, Ti-Zr-V, Zr-V-Fe getters are typically known as non-evaporable getters those studied earlier by some of the researchers [2-5]. Among them, Ti-Zr-Co based materials reviewed by the earlier investigators and found as suitable getter materials for application purpose [3]. Impact of rare earth elements (RE) on sorption characteristics of the Ti-Co-RE and Zr-Co-RE getter materials has been investigated and reported by the earlier scientists [6, 7]. Ti-Co-RE and Zr-Co-RE getter materials found to exhibit absorption of residual gases at required or considerable level. In this connection, it is observed that these materials characterization performed with limited techniques such as HTXRD, SEMEDX, TEM, XPS etc. Techniques like TG/DTG and DSC were less undertaken by them to explain sorption behaviour of those materials. Hence, aim of the present work is to explain sorption properties of the materials that added with rare earth elements. It facilitates to understand the impact of rare earth elements on sorption behaviour of the NEG materials through the spectra obtained due to techniques related to thermodynamical studies. The obtained results expected to throw light on mechanism of gettering process of the materials namely Ti-Co-RE and Zr-Co-RE alloys [8-10].

Experimental Details

The obtained Ti-Co-RE and Zr-Co-RENEG materials were sintered at a temperature of 1000°C. The present materials are characterized with HTXRD that manufactured by Anton Paar, HTK 16N/HTK 2000N available at BITS, GOA. The techniques namely Mettler Toledo TG/DTG851st and DSC apparatus available in AAL, AU possessing the range from room temperature to 1000°C in oxygen atmosphere having 10 °C/min heating rate at a constant applied pressure; SEM with EDS having the make JEOL, M006Fdel -JSM-6610LV and TEM manufactured by Philips model CM-220FEG located in advanced lab at Hyderabad also been used for characterization of materials. Measurements with the XPS technique were carried out. In this method excitation of photoelectrons takes place due to the sources XR6 Micro-focused Mono-Chromator (Al K α XPS), XR4 Twin anode Mg/Al (300/400W), X-ray source EX06 Ion Gun, model ESCALAB 250xi base system with ups and image mapping, make Thermo Scientific system that located at CSIR Lab in Kariakudi of Tamil Nadu state in India [7, 8]. Synthesis of the present materials in the form of flow chart is shown in Fig.1 as given below.

Easy availability of metal powders such as Titanium, Cobalt, Zirconium, (Sigma Aldrich with purity 99.9%), Samarium and Gadolinium (Central Drug House chemicals 99.9%) have been used as raw materials for preparation of the samples. The photos of the chemicals used in the present work are shown in Table 1. Prepared samples calcinations process is performed in alumina crucibles for 1 hour at 150 °C by using a muffle furnace box in air heating at the rate of 10 °C/minute. These materials have very high melting points and boiling point temperatures. These materials are sintered at 1000°C after making pellets for two hours. The chemical compositions of specimen's series are Ti_(1-x)-Co_x and Zr_(1-x)-Co_x (where x = 0.36, 0.32, 0.28, 0.24, 0.20). The rare earth series can also be written as Ti_(1-x)-Co_(x-3)-RE₃ and Zr_(1-x)-Co_(x-3)-RE₃, where x = 0.30, 0.26, 0.22, 0.18. Different characterization methods are employed to analyse the physical and chemical performance of the prepared NEG materials with the aid of various techniques namely high temperature X-ray diffraction (HT-XRD), Field Emission Scanning Electron Microscope (FESEM), Energy Dispersive Spectroscopy (EDS), High-Resolution Transmission Electron Microscope (HRTEM), Thermogravimetry (TG), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC), High-Temperature X-ray Diffraction (HT-XRD), X-ray Photoelectron Spectroscopy (XPS).

RESULTS AND DISCUSSIONS

The Fig.2(a) shows the obtained XRD pattern exhibiting highest intensity of the peak (2 2 2) cubic structure identified from the temperature 30°C to 450°C with JCPDS Card No # 00-007-0141. The phase change can be identified from the temperature 450°C to 1000°C with JCPDS Card No # 00-005-0719 with exhibiting hexagonal structure. The computed crystalline size (D) ranges in between 9.45 to 11.56 nm in increasing order reflecting the FWHM values range; 1.52 to 1.11(θ) in decreasing trend [11]. The XRD pattern shown in the Fig.2(b) is exhibiting highest intensity of the peak (1 1 0) orthorhombic structure identified from the temperature 30°C to 500°C with JCPDS Card No # 00-152-4752. The phase change can be identified from the temperature 30°C to 500°C with JCPDS Card No # 00-025-0259 with





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exhibiting tetragonal structure. The computed crystalline size (D) values in the range 14.09 to 15.31 (nm) indicating increasing trend of these parameter values while the FWHM found to deteriorate from 0.92 to 0.76(θ) [12]. The photographs obtained the SEM with EDS studies of both studies are shown in Fig.3. These are indicating porous nature in both the series of materials increasing the specific surface area and gas sorption capacity. Moreover, all the prepared samples show porous structure, it allows the faster diffusion of the gas particles through the getter materials [10-13]. Photographs of microstructure traced with the TEM studies are shown in Fig. 4 for both series. Both the series is indicating increase of the particle size indicating corroboration with the values of crystalline size evaluated based on the XRD patterns. Average values related to particles size of the different concentrations computed due to TEM measurements lie in between 10.85 to 12.09 nm and 13.05 to 16.03 nm for Ti-Co-RE and Zr-Co-RE series respectively. These values are found to be close with the values obtained through the XRD pattern [14].

The obtained spectra of thermo gravimetric studies are shown in the Fig 5 of both series. Ti-Co-RE series displayed in the 5(a) indicates desorption of physisorbed gases from the temperature 30°C to 450°C while the same is observed from 30°C to 310°C for Zr-Co-RE series that displayed in the Fig 5(b). From 450 °C and 310°C onwards reflecting sorption of oxygen gas particles till to 950°C. Curves related to differential scanning calorimeter measurements for both the series that shown in Fig 5(c) and (d) are showing exothermal behaviour in the range 180°C to 250°C. This may be due to the reaction of the getter alloy with oxygen gas particles. Further fall of curves with a broad width from 250°C to 350°C is showing endothermic nature of materials in this temperature range [15]. The X-ray photoelectron spectroscopy (XPS) studies have been performed for surface analysis of the present materials and to understand chemical modification on the surface of the getter material. The X-ray photoelectron spectroscopy (XPS) analysis has been performed for surface characterization of the present materials. The observed spectra of XPS for Ti-Co-RE and Zr-Co-RE series materials are shown in the Fig.6. The obtained wide scanned XPS spectrum is illustrated which shows the constituents of the material relating to air exposed surface of the specimen. In the case of Ti 2p spectra the maximum binding energies (BE) are noted in the form of peaks; further observed the movement of peak towards lower energy as a function of x (Ti increases, Co decreases).

The Ti 2p spectrum is considered due to the oxidation on the surface layer of the specimen and most likely appears as the Ti₂O compound. Similarly, the maximum values observed in the spectra of Co 2P and C 1s found to move towards lower BE values in Fig.6. Spectrum of the Zr 3d relating to its characteristic nature on the surface of the sample is shown in the Fig.6, which reflecting two peaks. This doublet may be due to spin orbit interaction that moves towards lower binding energies. This variation may be due to the changing chemical nature or binding of element(s) on the surface of present alloys.

CONCLUSIONS

In the present work both the series found to enhance their sorption behaviour as a function of rare earth element concentration. Techniques like TG/DTG and DSC also facilitated to understand sorption nature of NEG materials, which are not available at considerable level in the literature. The surface analysis of the present materials has been carried out by using XPS spectra. This facilitated understanding chemical behavior and molecular structure of alloys relating to the getter materials.

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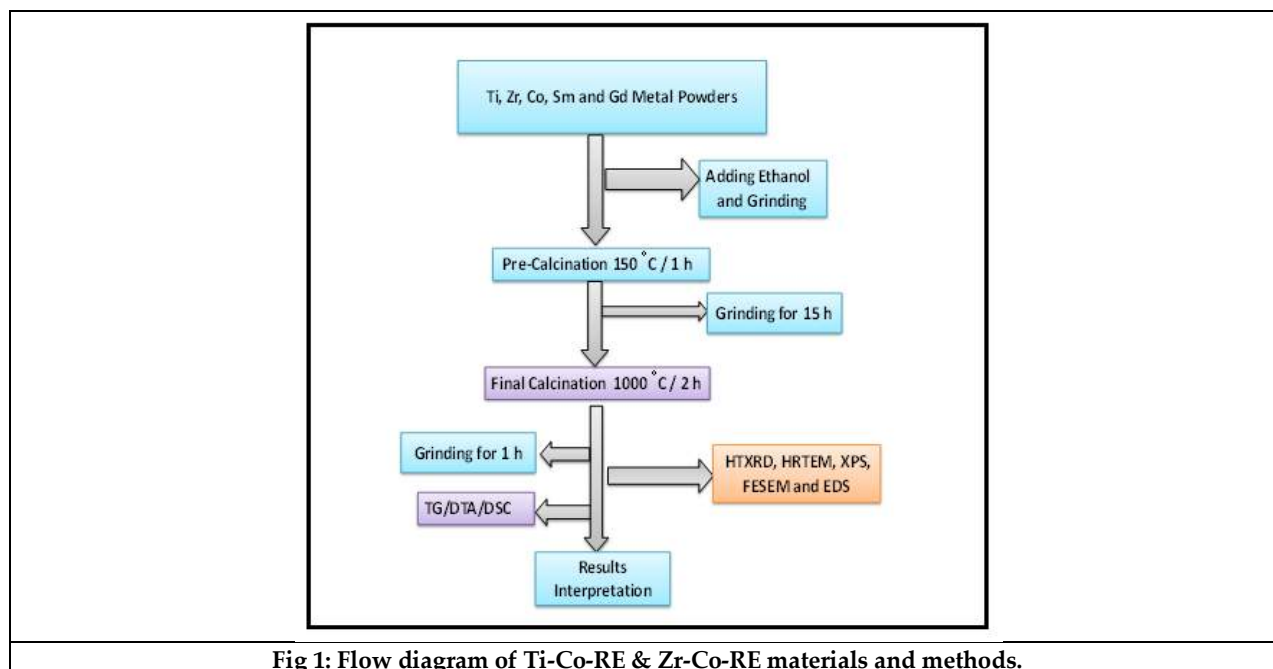


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Table 1: List of chemical compounds used for the synthesis of specimens.

Raw Materials	Chemical Formula	Purity (%)	Suppliers
Titanium Metal Powder	Ti	99.9	Sigma Aldrich
Zirconium Metal Powder	Zr	99.9	Sigma Aldrich
Cobalt Metal powder	Co	99.9	Sigma Aldrich
Samarium Metal Powder	Sm	99.9	Central Drug House (CDH) Chemicals
Gadolinium Metal Powder	Gd	99.9	Central Drug House (CDH) Chemicals
Acetone	C ₃ H ₆ O	99.5	HI-media
Ethanol	C ₂ H ₆ O	99.9	Merck

**Fig 1: Flow diagram of Ti-Co-RE & Zr-Co-RE materials and methods.**

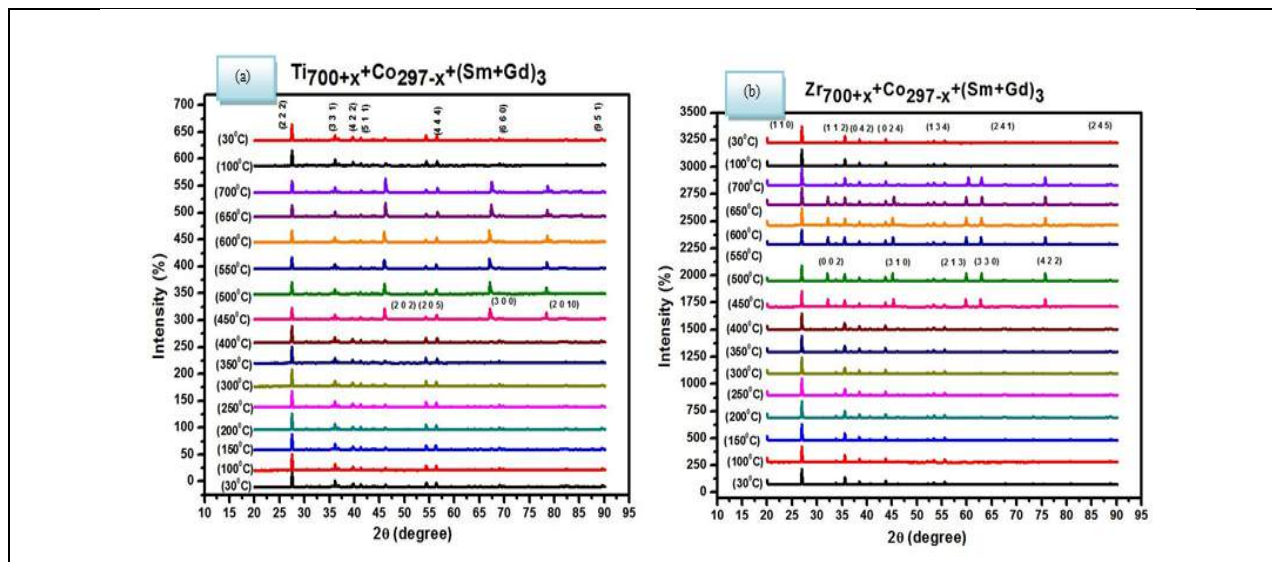


Fig 2:XRD patterns of(a)Ti-Co-RE and (b)Zr-Co-RE seriesalloys.

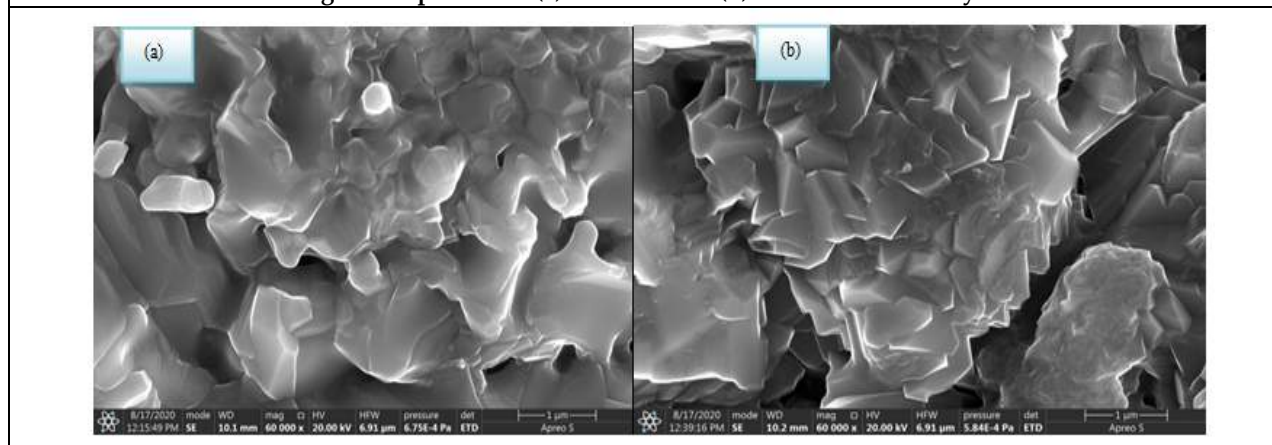


Fig. 3: SEM micrographs 1(μm) of (a)Ti-Co-RE and (b) Zr-Co-RE.

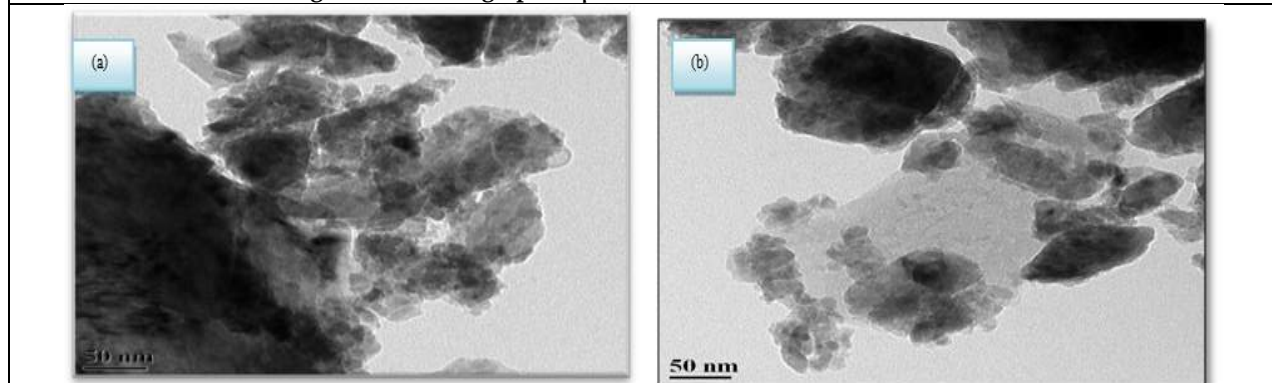


Fig. 4: TEM 50(nm)images of(a)Ti-Co-RE and (b) Zr-Co-RE



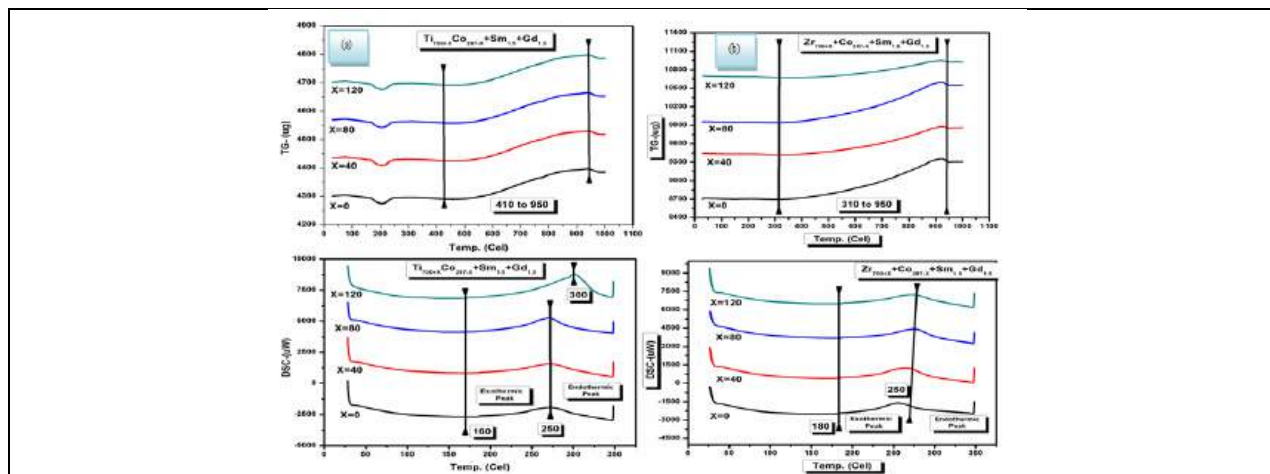


Fig. 5: TG/DSC results of (a) Ti-Co-RE and (b) Zr-Co-RE

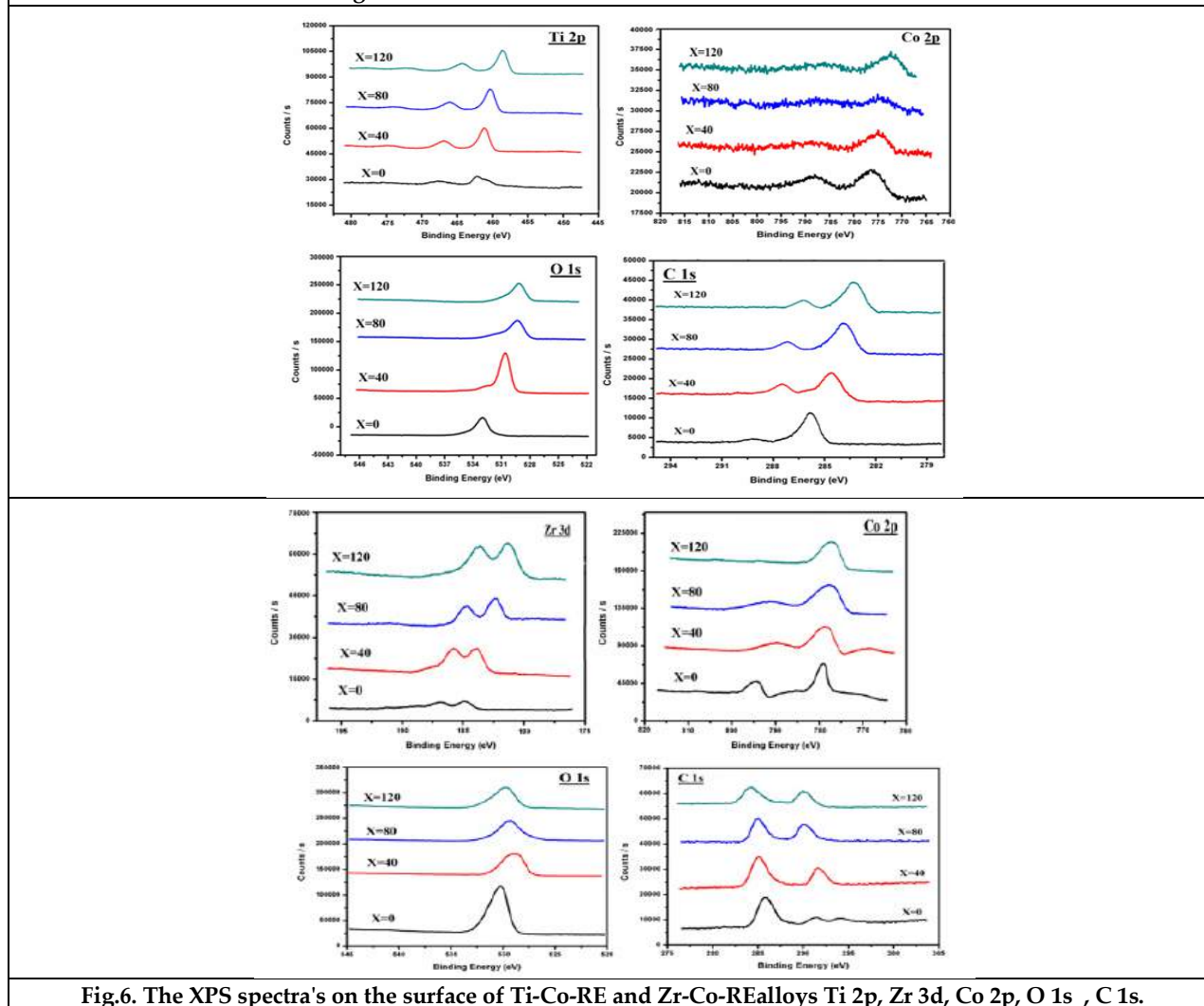


Fig.6. The XPS spectra's on the surface of Ti-Co-RE and Zr-Co-RE alloys Ti 2p, Zr 3d, Co 2p, O 1s , C 1s.





The Impact of COVID-19 on Libraries and Information Services Challenges, Innovations and Future Directions

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ABSTRACT

The COVID-19 pandemic profoundly affected libraries and information services worldwide, compelling them to swiftly adjust to an extraordinary crisis. This study investigates the immediate consequences of COVID-19 on library functions, encompassing closures, limitations on access, and disruptions in staffing, alongside the rapid transition to remote services. It underscores the essential role that libraries assumed in facilitating remote education and the innovative services that emerged during the pandemic. Furthermore, it addresses the challenges encountered by libraries, such as the digital divide and inadequate digital infrastructure. Lastly, the study considers the long-term effects of the pandemic and the prospective trajectory for libraries, emphasizing hybrid service models, the mission of enhancing digital literacy, and ensuring equitable access to resources.

Keywords: Libraries and Information Services, Remote Education, Covid-19, Virtual Services, Library Closures, Digital Divide, Virtual Programming, Hybrid Service

INTRODUCTION

The COVID-19 pandemic instigated profound transformations across various sectors, notably in education and public services. Libraries, traditionally viewed as essential resources for information access and community involvement, were not immune to these disruptions. Confronted with widespread closures, access limitations, and an urgent necessity to shift services to digital platforms, libraries rapidly adapted to maintain their support for local communities. This paper investigates the responses of libraries to the pandemic, the significant innovations that



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emerged, the immediate and enduring effects of these adaptations, and the prospective direction of libraries in a post-pandemic landscape.

Context

Before the onset of the pandemic, libraries had been progressively enhancing their digital offerings; however, the crisis necessitated a swift acceleration of this digital evolution. The pandemic revealed the weaknesses in libraries' operational frameworks, particularly concerning the digital divide and their insufficient readiness for extended closures. Libraries experienced a surge in demand for digital services, with user needs ranging from access to e-books and online databases to virtual programming and remote research assistance.

Research Objective

This paper aims to analyze the repercussions of COVID-19 on libraries and information services, concentrating on:

1. The immediate operational hurdles encountered during the pandemic.
2. The innovations and modifications libraries implemented to continue serving their communities.
3. The long-term consequences for library services, especially regarding future service models and equitable access.

Importance of the Study

This research is significant as it underscores the resilience and adaptability of libraries amid a global crisis. Gaining insights into how libraries reacted to COVID-19 and the lessons derived from these experiences is vital for future preparedness, ensuring that libraries can uphold their missions in both stable and crisis situations. Furthermore, the study illuminates persistent issues related to the digital divide and access inequity.

Structure of the Paper

1. Immediate Impacts of COVID-19 on Library Operations
 - a. Library Closures and Access Limitations
 - b. Transition to Virtual Services
 - c. Disruptions in Staffing and Workflow
2. The Role of Libraries in Supporting Remote Education
3. Innovations and New Services Introduced During the Pandemic
4. Challenges Faced by Libraries during the Pandemic
5. Long-Term Impacts and Future Directions for Libraries
6. Conclusion
7. References

Immediate Effects of COVID-19 on Library Operations

• Library Closures and Access Limitations

As the COVID-19 pandemic unfolded, libraries worldwide were compelled to shutter their physical locations in adherence to public health mandates. This led to the cessation of numerous conventional services, such as physical lending, face-to-face reference support, and community events. In response, libraries had to swiftly pivot their operations, emphasizing digital services and remote access to sustain engagement with their patrons.

• Transition to Virtual Services

In light of the closure of physical facilities, libraries rapidly adapted by enhancing their digital offerings and remote services. Many expanded their e-book collections and increased access to various databases and digital journals. The implementation of virtual reference services, online programming, and digital learning platforms became crucial for fostering user interaction. Libraries emerged as vital resources in aiding both educational institutions and the broader community in their shift to online learning environments.

• Disruptions in Staffing and Workflow

The pandemic significantly impacted library staffing, with numerous employees either working from home or experiencing furloughs. The challenge of managing workflow changes, sustaining staff productivity, and ensuring



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the delivery of essential services in a remote context was considerable. Additionally, libraries had to implement new safety measures for those staff members who remained on-site to manage material circulation and maintain technical infrastructure.

The Role of Libraries in Supporting Remote Education

During the pandemic, libraries emerged as vital components of the educational framework. Academic libraries ensured that students and faculty had remote access to a variety of digital resources, such as e-books, research databases, and multimedia content. Public libraries contributed to K-12 education by providing digital storytimes, online homework assistance, and literacy initiatives. Additionally, many libraries established new virtual learning environments, which included digital literacy workshops and programs focused on career development.

Innovations and New Services Implemented During the Pandemic

The pandemic prompted a wave of innovations in library services:

- **Curbside Pickup and Contactless Returns:** To maintain the circulation of physical materials, libraries adopted curbside pickup and contactless return options.
- **Virtual Programming:** Libraries broadened their programming to encompass virtual story times, author discussions, workshops, and community gatherings.
- **Collaborative Platforms:** Libraries either developed or collaborated with online platforms to create virtual meeting spaces, forums, and environments conducive to collaborative learning.
- **Extended Digital Access:** Libraries engaged in negotiations with publishers and database providers to enhance access to digital resources and remove borrowing limitations on e-books.

Challenges Faced by Libraries During the Pandemic

- **Digital Divide:** The pandemic intensified the existing digital divide, as numerous users struggled with inadequate internet access, lack of devices, or insufficient skills to utilize digital library services.
- **Budget Constraints:** Libraries confronted budget reductions and financial instability, which hindered their capacity to invest in new technologies or broaden their service offerings.
- **Staffing Shortages:** The implementation of staff furloughs and the shift to remote work presented operational difficulties, necessitating staff retraining to effectively manage new digital services.

Long-Term Effects and Future Perspectives for Libraries

Hybrid Service Models

In the aftermath of the pandemic, libraries are anticipated to implement a hybrid service model that integrates both physical and digital services. This approach may encompass the continuation of curbside pickup, the provision of both in-person and virtual programming, and the enhancement of digital collections alongside traditional physical resources.

Digital Literacy and Access

The role of libraries in bridging the digital divide and fostering digital literacy is expected to grow significantly. This will involve offering training sessions on digital tools, internet safety, and information literacy, thereby ensuring that all members of the community can effectively utilize online resources.

Equity and Access

Tackling disparities in access to information will remain a fundamental objective for libraries. They will persist in their efforts to ensure equitable access to both physical and digital resources for marginalized populations, including forming partnerships aimed at expanding broadband connectivity.

Resilience and Preparedness

Libraries are likely to allocate more resources towards disaster preparedness and resilience strategies, thereby ensuring the continuity of services during future emergencies.



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CONCLUSION

The COVID-19 pandemic necessitated a rapid transformation within libraries and information services, resulting in innovations that are poised to influence the future landscape of the sector. Despite facing considerable immediate challenges, libraries exhibited remarkable resilience, ingenuity, and a steadfast dedication to their communities. In the future, it is anticipated that libraries will embrace a hybrid service model, maintain an emphasis on digital literacy and equity, and enhance their readiness for potential emergencies.

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Various Tools Employed in Digital Forensics and their Primary Focus – A Review

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ABSTRACT

Within the field of forensics, digital forensics involves the extraction, analysis, and production of digital evidence to a court by investigators. Using forensic tools or software, digital forensics is a scientific inquiry to locate data evidence from digital devices. There is a number of forensic instruments available nowadays. Selecting and using the optimal option may prove to be decisive in a legal setting. Thus, it becomes necessary to rate and compare various forensic instruments. Test cases must be prepared in order to evaluate various forensic techniques under specific conditions. To improve crime examination and evidence identification, testing, categorization, and mapping can assist forensic professionals and investigating police in selecting the most appropriate tool from a variety of options. Sorting through the various forensic tools by categories can help you save time while selecting a tool.

Keywords: digital forensic, digital tools, cybercrime, live forensic, network forensic.

INTRODUCTION

Digital data permeates every aspect of our lives and is essential to any type of inquiry into cybercrime. Binary representations make up digital data, which also includes text, photos, audio, video, and other types of information. Currently, a large number of cybercrime incidents involving digital data have surfaced, including hacking, banking fraud, phishing, email spamming, etc. A very new and challenging area of computer science is called "digital





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forensics." A scientific method for gathering, storing, examining, removing, and reporting digital evidence from digital sources such as computers, smart phones, cameras, and other devices is known as "digital forensics." [1,2,3] As was mentioned above, there are numerous subfields within forensic science; however, we are focusing on desktop, network, and real-time network forensics.

In this case, a computer is either the source or the target of a digital crime. One kind of digital forensics is desktop forensics, which allows us to extract data from the operating system and hard drive. Numerous software applications are needed in order to restore ProDiscover Basic, Cyber Check Suit, FTK Analyzer, Recuva, and other deleted files Calm Down, etc. [4,5,6,7,8]

Desktop Forensic

A kind of digital forensics called desktop forensics is used to retrieve digital data from secondary memory. It addresses the process of retrieving erased files. In terms of cybercrime, recovery is a crucial idea. In this case, a computer is either the source or the target of a digital crime. One kind of digital forensics is desktop forensics, which allows us to extract data from the operating system and hard drive [9]. Numerous software applications, such as ProDiscover Basic, Cyber Check Suit, FTK Analyzer, Recuva, Ease Us, etc., are needed to recover the deleted file.

The investigator's primary focus in this area of computer forensics is recovering the system's secondary memory, or hard disk. The tools to test desktop forensics apps are as follows:

ProDiscover Basic- With ProDiscover Basic, the hard drive data is examined. During court procedures, this forensic tool is used. It is beneficial to gather information, image that information, and then assess its recovery. It is easy to search for data that has to be retrieved thanks to its superb searching capability [10]. Data can be seen in both a cluster and content view. It is having the issue for performance.

Encase - Gathering, examining, classifying, retrieving, and reassembling evidence is the aim of the Encase Digital Forensic tool. It also serves to assess digital evidence obtained via the Digital Forensic inquiry process. Encase is another well-known conventional method, and courts use its outcomes. It has the drawback of being more costly and requiring more time to hunt for [11].

Recuva - Recuva is a Windows data recovery tool program that can be downloaded for free from the market. [12] Files that are irreversibly erased but are not overwritten can be recovered using it. Additionally, you may use this tool to recover deleted files from MP3 players, hard drives, and USBs.

Cyber Check Suit - This tool can also be used for data recovery and digital evidence analysis in cyber forensics. True Back image tool imaging is required for Cyber Check. For a novice, the cyber check's graphical user interface is fairly simple to use [13]. A report of the investigating expert's analysis findings can also be produced by CyberCheck and submitted in court. Using file hashes and file signatures, the program offers options to perform analysis and can report on unallocated and disk slack space. Facing the problem of low detection accuracy in comparison to other.

Autopsy - The Sleuth Kit collection is integrated with Autopsy, an open source application. The program's graphical user interface (GUI) shows the findings of the investigators' forensic tool search, which highlights a significant portion of the data. [14,15] The tool's development company offers the necessary instruction.

Live Forensics

A subfield of digital forensics known as "live forensics" is responsible for recovering digital evidence from primary memory, with a particular emphasis on RAM data. In this instance, RAM data—such as cookies, registry keys, and browser information—is utilized as digital evidence in a live forensic case. It addresses the RAM dump [16]. RAM dumps refer to the process of extracting RAM-related data. There are numerous software tools available to extract RAM data. Certain tools, such as Volatility Framework, OSF Mount, Win-Lift, Belkasoft, etc., are licensed versions, while others are available as open-source software.

Within the field of digital forensics, the investigators at Live Forensics concentrate on extracting RAM features. The tools to test live forensics apps are listed below.

Win-Lift - A forensic tool called Win-Lift Analyzer is used for real-time analysis of RAM data that Win-Lift Imager has obtained. It generates forensic proof and a comprehensive report. The information that has been examined will be



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utilized to properly report the statistics. It produces distinct memory-related forensic objects[17].The running files, log, open socket file, etc., will all be extracted.It is having the security issue.

Belkasoft - An investigator can find, discover, examine, and distribute digital evidence on a computer with the aid of the Belkasoft program. This tool analyzes data from different volatile memory sources to obtain digital evidence in terms of proof [18]. This program automatically checks the data source and stores the RAM data for an expert to study and look over. It also analyzes evidence data that the tool has already examined.

Magnet RAM - A program called Magnet RAM Capture works with Windows versions XP, Vista, 7, 8, and 10. The entire live memory evidence will be extracted, and a volatile trace will be examined. Memory analysis is a crucial function of this application, which is utilized for malware detection and data recovery. It retrieves the active processes and applications, registries, passwords, keys, and so on. These are but a handful of instances of the proof that can be gleaned from memory[19].

OSF Mount - RAM is created on a disk that is mounted into RAM using OSF Mount. This is utilized instead of the hard drive for high-speed memory.This tool is helpful for a number of applications, including browser files, database applications, and cache files.Security is another advantage; for example, when a system is shut down, data on the volatile drive is automatically deleted[19]

Volatility Framework - An open source tool for examining RAM evidence is called Volatility. Windows OS and Linux are supported by this tool. It runs on Linux and Windows systems and is written in Python. It can analyze virtual box dumps, crash dumps, RAM dumps, and more.

Network forensics

One area of digital forensics is live network forensic tools. It covers topics like topology identification, packet spoofing, and real-time packet sniffer. Here, the live network's digital evidence extraction was the primary focus. It is possible to collect forensic packet information from the live network. Numerous real-time network forensic tools are available, including Wireshark, NMAP, Ettercap, Nessus, and others.

In the subject of digital forensics known as "network forensics," the investigator concentrates on packets moving through a network.The tools listed below can be used to test network forensics applications:

Wireshark - Wireshark is a packet analysis program that is widely used in the industry to investigate packets within networks. It is essential for a great deal of initiatives that might be developed with the network. This program reads and writes packets as well as captures files. We will analyze this capture file using the Wireshark software. While there are many more tools out there, Wireshark is one of the greatest[21,22].

Ettercap - This free and open source program is used to assess man-in-the-middle attacks.This tool is used to investigate computer network protocols, security audits, and packet tracing. It has the ability to control network segment traffic and capture passwords.

Nmap - Nmap is a network protocol port scanner program that offers security features. It is employed in computer networks to identify hosts and deliver services. As a result, it is employed to map services to networks. Basically, the purpose of Nmap (Network Mapper) is to send a craft packet to the target host in order to examine the contents and port of the source and target data[23,24].

Nessus - A security auditing tool called Nessus is used to do a network scan.After scanning a machine, it will produce a notice regarding a vulnerability that malevolent hackers have created.Any computer connected to the network can become infected with it. This program simulates several computer attacks that could damage our computer system[21].

Snort - An open source tool called Snort is used to analyze packets on various IP logging systems, detect network traffic, and log them.It facilitates packet tracking and protocol finding. In a network, Snort is used to provide QOS. Thus, this program can analyze large amounts of data into a network[25].

RESULT AND DISCUSSION

In the contemporary context, a variety of digital forensics techniques and tools are used to prevent and detect cybercrime. The report presents a comparison of a set of parameters and forensics application tools.Using this



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technique, forensic experts and investigators can select the best forensic tool for their requirements. The investigation can go smoothly as a result.

Imaging- Bit-by-bit copies of the hard disk are called images. It transfers all zeros and ones from one hard disk to another. It is done by using the tool encase, cyber check suit, autopsy, win lift, Belkasoft, magnet RAM, OSF mount.

Hashing - Hashing verifies the integrity of the data used to confirm the drives' image by using the hash function. It can be performed by ProDiscover basic, encase, cyber check suit, win lift, magnet RAM, Volatility framework,.

Recovery–The process of recovering data from a deleted drive is called recovery. It is employed to retrieve preexisting data. ProDiscover Basic, Encase, Recuva, and Cyber Check Suit are the primary desktop forensic tools used for this process.

Acquire - It alludes to locating the digital evidence stored on the hard disk. Tools like encase, cyber check suit, autopsy, recuva, and belkasoft are employed for it.

Seizer - By imaging, Seizer helps to maintain the hard disk. Tools like ProDiscover Basic, Encase, Cyber Check Suit, Win Lift, Magnet RAM, Volatility Framework, Autopsy, Belkasoft, and OSF mount are utilized for this purpose.

RAM dumping-It speaks about the extraction of RAM data, including registry data, cookies, and browsing history. Most often, live forensics are used, and tools like Win Lift, Magnet RAM, Volatility Framework, Autopsy, Belkasoft, and OSF mount are used.

Live log - The logical files generated in live situations are contained in it. Win lift, magnet RAM, Volatility framework, autopsy, Belkasoft, and OSF mount are among the tools that gather it in live forensics.

Live analysis - The RAM data can be extracted from the RAM dump image with the use of live analysis. It is gathered in live forensic using instruments such as Belkasoft, OSF mount, autopsy, magnet RAM, win lift, and volatility framework.

Search – To search is to look for content in both the image and the hard disk that has been examined. ProDiscover Basic, Encase, Cyber Check Suit, Win Lift, and OSF Mount are the tools used to accomplish this.

Logs –A logical file called a log can be obtained through data analysis. ProDiscover Basic, Win Lift, Volatility Framework, OSF Mount, and Wire shark are the tools used to do it.

Reporting - Reporting is the process of creating accurate documentation following the use of a forensic tool. ProDiscover Basic, Encase, Cyber Check Suit, and Win Lift are the tools utilized for this.

Packet sniffing – It gathers data on the packets moving over the network. It is employed in network forensic analysis through the use of the tools Wire shark, Ettercap, Nmap, Nessus, and Snort.

Packet analyzer - It is employed to examine packet data, including IP, MAC, and firewall data. It is utilized in network forensics using tools like Ettercap, Nmap, Wireshark, Nessus, and Snort.

Packet spoofing -Spoofing is the act of concealing the sender's identity. IP information is extracted here. It is utilized in network forensics with the Wireshark, Ettercap, Nmap, Nessus, and Snort tools.

Protocol - It shows the guidelines that the tools adhere to. It is utilized in network forensics with the Wireshark, Ettercap, Nmap, Nessus, and Snort tools.

Open Port – It assists us in locating open ports in IP connections that are necessary for servers and applications. Tools utilized include snort and Nmap.

Topology – It describes how network representation is arranged. Nessus, Nmap, and Ettercap are the tools used.

CONCLUSION

In order to ascertain which forensic instrument is superior in relation to the parameters, a comparative analysis is conducted using the results obtained from the various tools. Future projects will map out digital forensic tools and improve data security, accuracy, dependability, and other privacy safeguards by conducting a comparative analysis on a sizable number of forensic tools. Future research can also make use of a plethora of additional features and tools in the upcoming years and give the comparison between that tool and parameter. We'll also try to get some CFTT research to test the tools, and we might also include a few more parameters for comparison.





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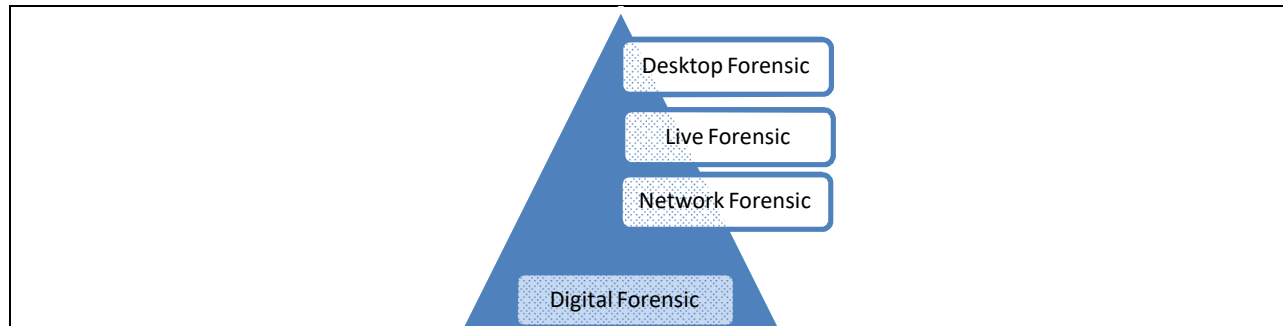


Figure- 01. Showing the type of digital forensic describe in this paper.

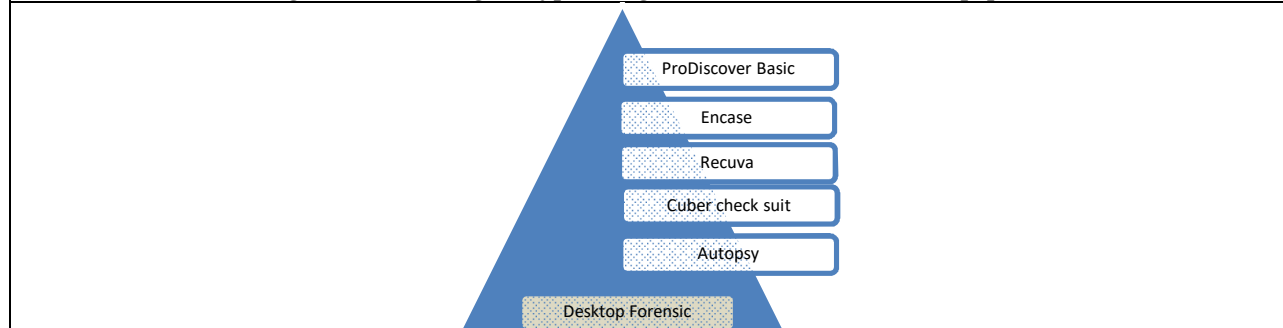


Figure-02 Showing the tools named used for desktop forensic.

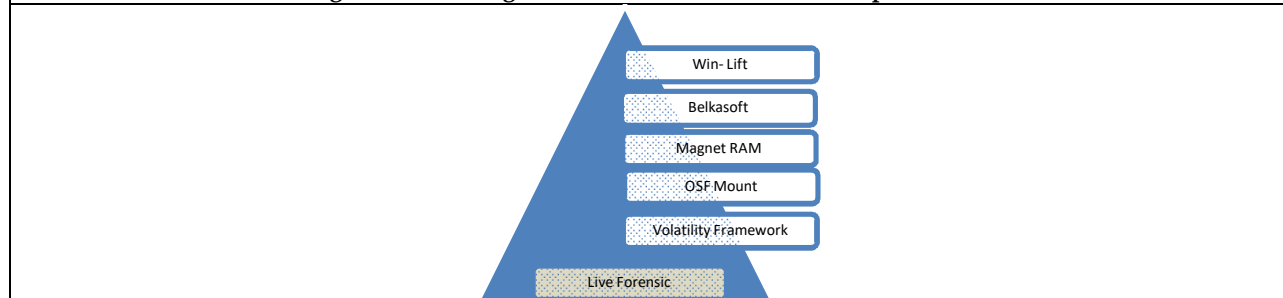


Figure-03. Showing the tools named used for Live forensic

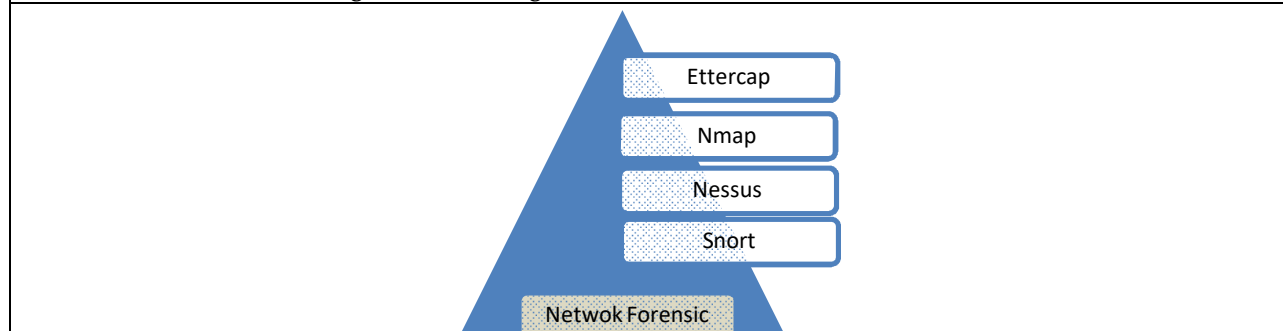


Figure-04. Showing the tools named used for Network forensic





The Relationship between Dividend Policies and Profitability: A Mini Review

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ABSTRACT

Dividend policy plays a crucial role in the modern business environment, shaping the financial decisions of organizations. It establishes guidelines for determining the portion of earnings to be distributed to shareholders as dividends and the portion to be retained for reinvestment. While dividends reward shareholders for their financial contributions, dividend policy also serves as an indicator of a company's financial health, providing critical information to stakeholders. This paper explores the relationship between profitability and dividend payout ratios, focusing on measures such as Return on Assets (ROA) and Return on Equity (ROE). A mini-review of previous scholarly articles was conducted to assess the link between profitability and dividend decisions, highlighting the role of dividend policy in maximizing shareholder wealth while promoting long-term organizational growth.

Keywords: Dividend policy, Profitability, Return on Assets (ROA) and Return on Equity (ROE)

INTRODUCTION

In today's business environment, dividend policy has become a critical aspect for organizations. A dividend policy outlines the guidelines and procedures for making financial decisions regarding the payment of dividends to shareholders, typically announced at annual general meetings as a distribution of earnings. The primary aim of financial management is not solely focused on benefiting shareholders but also on maximizing the wealth of the organization and its owners. The decision to declare and pay dividends became a significant issue in financial literature following the rise of public shareholding and joint-stock companies. Dividend policy is not only a tool for distributing the surplus of revenue after costs but also serves as a vital indicator for stakeholders, offering insights into a company's financial performance. Essentially, a company's dividend policy determines how much of its earnings or profits should be distributed to shareholders, investors, and creditors, and how much should be retained



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for reinvestment to fuel future growth and development. Dividends are considered rewards for those who provide financial resources to the company, serving as compensation for the risk taken by shareholders and investors. Several factors influence dividend distribution, and profitability is among the key determinants. In this study, researchers have explored the relationship between profitability and dividend payout ratios, using measures like Return on Assets (ROA) and Return on Equity (ROE). A mini-review was conducted by analysing previous scholarly works to provide insights into the research objective, findings, and results related to this association.

Importance of the Study

The exploration of the connection between dividend policies and profitability represents a vital facet of corporate finance, offering significant insights for both investors and businesses. This research investigates how dividend policies act as signals of a company's financial stability, thereby shaping investor perceptions and influencing stock market valuations. By examining the relationship between profitability and the distribution of dividends, the study seeks to provide corporate managers with guidance on effectively balancing reinvestment in growth with returns to shareholders. Furthermore, it highlights the effects of external economic conditions on this relationship, contributing to a more nuanced understanding that can inform strategic decision-making. The outcomes of this research are relevant not only to individual firms but also to broader market behaviors, underscoring the importance of this investigation within the field of finance.

Statement of the Problem

Every business has four crucial financial decisions that management must make in order to achieve the company's objectives. These include decisions on capital budgeting or long-term investments (applying funds), capital structure or financing (purchasing funds), dividends (distributing funds), and working capital management. Therefore, the distribution of funds directly related to financing and dividend choice, as well as the IT industry, play a critical role in the expansion and advancement of our nation's economy. In this context, a study has been conducted to determine how dividend policies are applied using a sample of Indian IT companies.

REVIEW OF LITERATURE

The literature review forms a crucial component of any research project. It provides insight into the work conducted by individual researchers and institutions, laying a foundation for future studies. Numerous studies have been conducted on dividend policy, with a particular focus on the relationship between profitability and dividend payments, both at the national and international levels. The key findings from several significant studies in this area are summarized below. Arnott and Asness (2003) discovered a positive relationship between dividend payout and future earnings growth in their study. They further noted that managers are generally hesitant to reduce dividends, as dividend payments positively impact a firm's profitability. Their research also revealed that a high payout ratio reflects management's confidence in the stability and growth of future earnings, while a low payout ratio suggests doubts about the consistency or sustainability of earnings growth.

Das (2006) conducted an empirical analysis on 'Dividend Practices in Selected Companies' and found that these companies followed a conservative dividend policy from 1989 to 2005. By applying correlation analysis to variables like DPS, EPS, and capital employed, the study demonstrated a high correlation between these factors.

Amidu (2007) investigated the impact of dividend policy on the performance of companies listed on the Ghana Stock Exchange, measuring performance by profitability. The study showed a positive and significant relationship between dividend policy and performance metrics such as return on assets, return on equity, and sales growth. It indicated that firms with dividend policies experience improved profitability, with a significant relationship between profitability and the dividend payout ratio. Kent and Dutta (2007), in their research on 'The Perception of Dividend by Indian Managers: New Evidence,' revealed that dividend-paying firms are generally larger and possess characteristics such as higher profits, greater cash flows, and more growth opportunities. Agyei and Marfo-Yiadom (2011) examined the relationship between dividend policy and the performance of banks in Ghana by analyzing



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panel data from the financial statements of 16 commercial banks between 1999 and 2003. Using STATA for data analysis, they found that dividend payments contribute to improving bank performance and concluded that dividend policy significantly influences a firm's value.

Arif *et al.* (2011) conducted research on Dividend Policy and Earnings Management in Pakistani listed companies, utilizing descriptive statistics, a correlation matrix, regression analysis, and the ANOVA model. Their findings indicated no significant relationship between ROE and dividend payout in large firms, while a positive relationship was found between small firms and dividend payments. They concluded that small companies tend to pay more dividends compared to large companies, where management focuses more on earnings management than on dividend payments. Uwalomwa *et al.* (2012) examined the relationship between financial performance and dividend payout among listed companies in Nigeria. The study, which analyzed 50 companies from 2006 to 2010, considered variables such as ownership structure, firm size, and dividend payouts. They found a significant positive correlation between firm performance and dividend payouts. Additionally, the study revealed that ownership structure and firm size significantly influence dividend payouts.

Patra *et al.* (2012) studied the factors influencing dividend policy in firms listed on the Athens Stock Exchange (ASE). Their findings indicated that dividend payout decisions are positively affected by firm size, profitability, and liquidity, while investment opportunities, leverage, and business risk negatively influence these decisions. Ajanthan (2013) explored the relationship between dividend payout and profitability in listed hotels and restaurants in Sri Lanka under the Colombo Stock Exchange. Using regression and correlation analysis, the study found a positive significant relationship between dividend payout and firm performance. Ajanthan further suggested that factors such as leverage, opportunities, and taxes should also be considered for creating an effective dividend policy. The study concluded that dividend policy plays a critical role in enhancing firm growth, profitability, and shareholder value. Balasundaram and Priya (2013) analyzed the impact of dividend policy ratios on firm performance using correlation and multiple regression analysis. They observed a positive significant association between dividend policy and firm performance. Yegon *et al.* (2014) investigated the effects of dividend policy on the financial performance of listed manufacturing firms in Kenya. Their findings indicated that dividend policy has a significant positive relationship with profitability, investments, and EPS. They further recommended that companies adopt strong dividend policies to enhance profitability and attract investor funding.

Chhatoi (2015) examined the relationship between profitability and dividend payment in India's iron and steel industry. Analyzing data from 2004 to 2012, the study looked at EPS, DPS, and payout ratios of selected companies. The results suggested that a firm's dividend decisions are significantly influenced by its profitability. Akani and Sweneme (2016) conducted an empirical study on dividend policy and profitability in selected manufacturing firms in Nigeria to examine the impact of dividend policy on profitability. Using multiple regression analysis, their findings indicated a positive relationship between dividend policy and profitability in these firms. They further recommended that both market forces and management practices should be encouraged to foster an effective dividend policy, which would, in turn, boost profitability in Nigerian firms.

Priya and Mohanasundari (2016) explored the impact of dividend policy on firm performance by reviewing both theoretical perspectives and empirical evidence. Their review highlighted that dividend policy holds different importance for management and shareholders. While management focuses on organizational growth, shareholders are primarily concerned with returns on investment. The empirical evidence from their study indicated a positive relationship between dividend payout and firm value. Sharma and Wadhwa (2017) examined the dividend patterns and trends of Indian corporate firms from 2002 to 2014. Their analysis, based on a large sample of stocks listed on the Bombay Stock Exchange (BSE), revealed that the percentage of dividend-paying companies increased by 28% over the 12-year period, while non-dividend-paying companies declined by 51%, shifting toward the dividend-paying group. A t-test comparing payer and non-payer groups demonstrated that dividend payments positively impacted profitability and other related factors.



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Thirumagal and Vasantha (2018) analysed the effect of dividend payout on shareholder wealth across five major industries in India: Automobile, Infrastructure & Construction, Energy, Information Technology, and Pharmaceuticals. Using 15 years of data (2001–2015) and applying panel data regression and paired t-tests, they found that dividend payouts negatively impacted shareholder wealth in most industries. They also observed significant differences in share prices before and after dividend announcements. Das (2020) assessed the influence of dividend policy on the financial performance of 50 companies from four industrial sectors listed on the Bombay Stock Exchange over seven years (2012–2019). Utilizing a correlation matrix and panel regression model, the study revealed that these companies did not follow a consistent pattern in dividend payments. The association between the price-earnings ratio and dividend payout ratio was found to be weakly positive, while there was a strong relationship between return on assets and return on equity. From this literature review, it is evident that numerous studies worldwide have explored the relationship between profitability and dividend payout. However, no clear consensus has been reached on the findings.

METHODOLOGY

In order to carry out this mini-review first of all I had to search for dividend policies and practices articles in the database. Not much research is done on the topic of this so, it was hard to find journal articles with the same title for the topic. Then I tried looking for different articles with different titles like I entered the topic. I found some articles but most of them were not related to my topic. Then I had to find those articles that talked about dividend payment in the finance field, read their abstracts and then keep them aside for my research. The next step was for me to choose finance-related articles for dividend policies and profitability thus those articles could only be from the year 2003 till 2020. After I found appropriate articles for my research, I had to check whether I could use those articles in my research or not. This was one of the major challenges for my research as it was really hard to find the articles. In Total, I had to choose 16 articles for my research. The review of literature describes the article's objective, findings and recommendations; hence it was very time consuming and thus it is a major part of my research. Then by using the these, I had to write down the discussions and results along with the conclusion and the references.

CONCLUSION

Overall, the articles selected for analysis consistently highlight that dividend payments are a crucial aspect of corporate finance. Dividend distributions provide investors and shareholders with greater transparency regarding the financial health of companies, making them more attuned to the profitability of the respective industries. As a result, stakeholders have become increasingly aware of the importance of profitability during dividend distributions. Furthermore, the articles emphasize that profit generation is a key factor in achieving organizational goals and financial targets. In conclusion, despite the relevance of this topic, there remains a limited amount of research on the relationship between dividend policies and profitability. The aim of this mini-review is to encourage further exploration and research in this area.

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Preservation of Cultural Heritage: Challenges, Technologies, and Future Directions

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ABSTRACT

Safeguarding cultural heritage is essential for maintaining a society's history, identity, and collective memory. As environmental degradation, urbanization, conflict, and the digital era pose increasing threats, there is an urgent need for innovative and effective cultural preservation strategies. This paper examines the primary challenges in preserving cultural heritage, analyzes the impact of emerging technologies such as digital archiving, blockchain, artificial intelligence (AI), virtual reality (VR), and augmented reality (AR) in addressing these issues, and suggests future pathways for ensuring the durability and accessibility of cultural heritage. By integrating case studies with a thorough review of existing literature, this research seeks to offer a holistic perspective on how traditional and digital preservation methods can collaborate to protect cultural assets for future generations.

Keywords: Cultural Heritage Preservation, Digital Archiving, Emerging Technologies, Blockchain for Cultural Heritage, Virtual Reality (VR) and Augmented Reality (AR), 3D Scanning, Artificial Intelligence

INTRODUCTION

Cultural heritage includes both tangible and intangible components that shape the identity and history of a community, nation, or civilization. This encompasses ancient monuments, historic structures, artifacts, as well as traditions, languages, and rituals. Protecting these cultural assets is crucial for ensuring their transmission to future generations, thereby nurturing a sense of identity and continuity. The preservation of cultural heritage has historically been a significant concern for societies worldwide. However, recent years have seen this endeavor



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become increasingly complex due to rapid urbanization, environmental shifts, armed conflicts, and technological advancements that necessitate new preservation methods. As societies progress, so too do the tools and strategies employed to safeguard heritage. Digital technologies have emerged as powerful agents of change, facilitating more efficient and accessible ways to preserve and disseminate cultural heritage. This research article seeks to examine the development of methods for preserving cultural heritage, with an emphasis on the incorporation of new technologies within this domain. It will discuss the obstacles encountered in both conventional and digital preservation initiatives and offer perspectives on future strategies for protecting our collective heritage.

Background

Cultural heritage is generally divided into two categories: tangible heritage, encompassing physical items like structures, monuments, and artifacts, and intangible heritage, which includes practices, rituals, oral traditions, and expressions that contribute to a community's identity.

The Significance of Preserving Cultural Heritage

Cultural heritage is essential in defining the identities of communities and societies. Its preservation guarantees that future generations can access the knowledge and values that have influenced the past, thereby fostering understanding and continuity. Moreover, cultural heritage plays a significant role in economic growth, especially through tourism, and enhances social cohesion by cultivating a sense of belonging.

The preservation of cultural heritage is crucial for several reasons:

Educational Significance: Cultural heritage offers valuable insights into the history, social dynamics, and values of various civilizations. It acts as a living resource for learning about historical societies and their interactions.

Identity and Continuity: Cultural heritage fortifies the identity of individuals and communities by linking them to their historical narratives. It provides a sense of continuity and belonging, instilling pride and respect for one's origins.

Economic Impact: Cultural heritage often serves as a significant catalyst for tourism, making substantial contributions to local economies. Heritage tourism can create employment opportunities, promote local artisanship, and support sustainable development.

Global Understanding and Collaboration: The preservation of cultural heritage encourages mutual understanding and collaboration among nations, emphasizing shared histories and values. It nurtures a global appreciation for diversity and the collective achievements of humanity.

Challenges in Preserving Cultural Heritage**Natural and Environmental Risks**

Cultural heritage faces significant risks from environmental influences, including natural disasters, climate change, and ecological degradation. Events such as earthquakes, floods, and wildfires can inflict serious damage on historical buildings, while increasing temperatures and shifting weather patterns may accelerate the deterioration of materials used in monuments, structures, and artifacts. For instance, the thawing of permafrost in areas like Siberia has resulted in the swift decay of ancient wooden edifices.

Urban Expansion and Development

The rapid pace of urbanization presents another major threat to cultural heritage. Growing cities frequently encroach upon historical sites, resulting in the destruction or modification of cultural landscapes. The need for new infrastructure and housing often conflicts with the imperative to protect historic buildings and neighborhoods. In certain instances, development pressures lead to the demolition of heritage sites to accommodate new construction projects.

Conflict and Looting

Armed conflicts have inflicted irreversible harm on cultural heritage across various regions. During times of war and civil strife, historic sites and museums are frequently targeted, either as representations of cultural identity or for economic gain. The looting and illicit trade of cultural artifacts tend to escalate during conflicts, as evidenced in countries like Syria and Iraq, where valuable cultural items have been smuggled and sold illegally.



**Binoda Kumar Nayak and Tapas Kumar Bhuyan****Digital Era and Data Preservation**

Although digitization provides new avenues for preserving cultural heritage, it also introduces challenges. Digital records, in contrast to physical artifacts, are susceptible to data loss, technological obsolescence, and cyber threats. To ensure the durability and accessibility of digital archives, ongoing updates to storage systems and software are necessary, along with effective strategies for data migration.

Innovative Technologies in the Preservation of Cultural Heritage

Innovative technologies have revolutionized the preservation, documentation, and dissemination of cultural heritage. These advancements not only offer new methods for protecting physical artifacts and sites but also improve public access and interaction with cultural heritage.

Digital Preservation and 3D Modeling

Digital preservation entails the creation of high-resolution digital representations of cultural artifacts, documents, and historical sites. Techniques such as 3D modeling and photogrammetry enable the production of intricate digital copies of historic structures and items, safeguarding them in a virtual environment even if the original objects are lost or compromised. This approach guarantees that cultural heritage remains available to future generations, despite potential physical threats.

A prominent instance of digital preservation is the 3D modeling of the ancient city of Palmyra in Syria. Following the city's partial destruction due to armed conflict, digital preservationists employed advanced scanning technologies to generate detailed models of the site, ensuring its legacy persists despite the physical devastation.

Blockchain for Tracking Provenance and Ownership

Blockchain technology provides a secure and transparent method for tracking the provenance and ownership of cultural artifacts. In the realms of art and antiquities, where forgery and illicit trade pose significant challenges, blockchain offers an unchangeable ledger for documenting the history of an artifact's ownership and transfer. By guaranteeing that records remain unaltered and secure, blockchain plays a crucial role in safeguarding the authenticity and integrity of cultural heritage.

Artificial Intelligence and Machine Learning

The integration of AI and machine learning holds significant promise for the preservation of cultural heritage by streamlining processes such as image analysis, data categorization, and the restoration of artifacts that have suffered damage. Tools powered by AI can sift through extensive cultural datasets, uncovering patterns and connections that might elude human researchers. Furthermore, these technologies play a crucial role in reconstructing lost or impaired cultural heritage by forecasting missing elements or rejuvenating faded images and texts.

Virtual and Augmented Reality (VR/AR)

The advent of VR and AR technologies has fundamentally altered the way cultural heritage is perceived and understood. With immersive virtual tours, individuals can visit historical sites and museums from any location, thereby broadening access to cultural heritage on a global scale. VR has been employed to recreate ancient cities and landmarks, enabling users to engage with these locations as they appeared in their original states. Conversely, AR applications enhance on-site experiences by superimposing digital information onto actual locations, offering deeper context and understanding of their historical importance.

3D Printing for Restoration

3D printing has emerged as a vital resource in the restoration and reconstruction of damaged artifacts. When original objects are too delicate or compromised for display, 3D printing facilitates the production of precise replicas suitable for educational and exhibition purposes. This technology proves especially beneficial in instances where artifacts have been lost or obliterated, enabling their physical recreation based on digital representations.

Case Studies**Case Study 1: The Notre-Dame Cathedral Fire (2019)**

The catastrophic fire at Notre-Dame Cathedral in Paris in April 2019 highlighted the significance of digital preservation. In the years leading up to the incident, researchers had developed intricate 3D scans of the cathedral's architecture and interior, creating a detailed digital framework for future restoration projects. These digital



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representations are currently being utilized as the basis for the ongoing restoration efforts, illustrating the essential role of digital archiving in safeguarding cultural heritage.

Case Study 2: Palmyra, Syria

As previously noted, the ancient city of Palmyra suffered significant damage due to conflict in Syria. Thanks to the dedication of digital preservationists, comprehensive 3D models of the site were produced using photogrammetry and 3D scanning methods. These digital replicas not only document the heritage that was lost but also lay the groundwork for possible physical reconstruction in the future.

Case Study 3: The British Museum and Digital Collections

The British Museum has adopted digitization as a strategy for preserving and disseminating its extensive collection of cultural artifacts. Through its digital collections platform, the museum offers online access to high-resolution images and detailed descriptions of its items, enabling global audiences to explore and engage with cultural heritage. This digital initiative has made the museum's collection available to individuals who may never have the chance to visit in person, showcasing the impact of digital technologies in enhancing access to cultural heritage.

Ethical Considerations in Cultural Heritage Preservation

The preservation of cultural heritage presents numerous ethical challenges, especially regarding ownership, control, and the utilization of heritage assets. A significant ethical discussion revolves around the repatriation of cultural artifacts that have been looted or stolen, with a focus on returning these items to their countries of origin. Numerous institutions in Europe and North America hold artifacts that were obtained during colonial times, often under dubious circumstances. In recent years, there has been an increasing demand for the restitution of these items as nations strive to reclaim their cultural identity. Additionally, the digitization of cultural heritage raises ethical concerns. Although digital technologies provide innovative methods for preserving and disseminating heritage, there are apprehensions regarding the commercialization of cultural assets and the risk of exploitation. Indigenous communities, in particular, may express reservations about the digitization and distribution of their cultural heritage without their explicit consent or oversight.---

Future Directions

The trajectory of cultural heritage preservation will be influenced by ongoing technological innovations, international collaboration, and an increasing recognition of the ethical and environmental issues associated with protecting heritage. Key areas for future preservation initiatives include:

Sustainable Preservation

With climate change presenting serious risks to cultural heritage, it is essential for the field to emphasize sustainable preservation strategies. This involves the creation of innovative materials and methods for the restoration and upkeep of historical sites in response to environmental challenges.

Global Collaboration

Cultural heritage is a collective global asset, necessitating worldwide cooperation for its preservation. Future initiatives should aim to establish networks among preservationists, researchers, and governmental bodies to exchange knowledge, resources, and effective practices. Organizations like UNESCO are vital in facilitating these collaborations, especially in areas impacted by conflict or environmental crises.

Expanding Access

Digital advancements offer the opportunity to broaden access to cultural heritage, allowing it to reach a worldwide audience. However, it is crucial to ensure that this access is inclusive and honors the cultural values and rights of the communities involved. Future preservation efforts should emphasize the participation of local stakeholders in decision-making, ensuring that cultural heritage is maintained in a manner that reflects their values and priorities.---

CONCLUSION

The safeguarding of cultural heritage is a vital undertaking that guarantees the continuity of our collective history and identity. While conventional preservation techniques remain significant, innovative technologies such as digital





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archiving, artificial intelligence, and virtual reality present new opportunities for the protection and dissemination of cultural heritage. Nonetheless, these advancements introduce challenges, particularly regarding sustainability, ethical considerations, and accessibility. To effectively maintain cultural heritage for future generations, it is essential to find a harmonious balance between traditional and modern approaches, ensuring that preservation initiatives are sustainable, inclusive, and considerate of cultural diversity. By adopting new technologies and promoting international cooperation, we can secure the cultural heritage of today for the benefit of future generations.

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Simulation of Electric Vehicles: A Case Study

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ABSTRACT

“Current Research work highlights the significance of simulating an Electric vehicle in MATLAB which is approached through several interconnected components such as the electric motor, battery, vehicle dynamics, and control strategies. This article typically focuses on different aspects like vehicle dynamics, battery performance, motor control, and energy consumption. Further, an outline for building a comprehensive electric vehicle simulation model is demonstrated with a case-study. In addition, advantages and typical applications of Simulation in Electric Vehicles are presented. Thus, by leveraging simulation technologies, the development of electric vehicles becomes more efficient, cost-effective, and aligned with sustainability goals, leading to better performance and user satisfaction in real-world applications”

Keywords: Electric Vehicles (EVs), Simulation of EVs, MATLAB, Simulink, Optimization, Battery Management Systems.

INTRODUCTION

“Simulating an electric vehicle (EV) in MATLAB can be approached through several interconnected components such as the electric motor, battery, vehicle dynamics, and control strategies. Below is an outline for building a comprehensive EV simulation model” [1].



Deepak Kumar *et al.*,**Key Components for Electric Vehicle Simulation**

1. **“Vehicle Dynamics Model:** Describes the motion of the vehicle in response to forces like aerodynamic drag, rolling resistance, and acceleration [2].
2. **Electric Motor Model:** Defines the performance of the motor based on torque, speed, and efficiency maps.
3. **Battery Model:** Simulates the battery’s state of charge (SoC), voltage, and current as it delivers power to the motor [3].
4. **Regenerative Braking System:** Captures energy during braking and returns it to the battery [4].
5. **Control System:** Implements feedback control strategies to manage vehicle speed, motor torque, and regenerative braking” [5].

Advantages of Simulation in Electric Vehicles (EVs)**Cost-Effective Development:**

“Simulations help manufacturers avoid costly physical prototyping by testing vehicle performance, power trains, and battery systems in virtual environments before actual production. This reduces the need for building multiple prototypes, saving both time and resources [6].

Accelerated Development Process:

Simulations allow for rapid testing of various designs, systems, and components under different conditions, leading to quicker iterations and refinement of the EV. This accelerates the time-to-market for new models [7].

Safety Improvements

Simulating crash scenarios, battery failure, or other dangerous conditions allows engineers to identify potential safety issues and resolve them before real-world testing, enhancing overall vehicle safety” [8].

Performance Optimization

“Engineers can use simulations to optimize the efficiency of electric powertrains, energy consumption, and battery life under various driving conditions (e.g., different speeds, loads, or temperatures), leading to better performance of EVs in real life [9-10].

Predictive Maintenance

Simulations allow for modeling wear and tear on components like batteries, motors, and electronic systems, which helps predict potential failures and optimize maintenance schedules, reducing downtime [11].

Environmental Impact Analysis

The environmental impact of an EV can be accessed through lifecycle simulations, from production to recycling. This helps companies focus on sustainability by optimizing materials and manufacturing processes for minimal environmental footprint [12].

User Experience Enhancement

Human behavior and interaction with EVs (e.g., user interface, charging experience) can be simulated to improve the overall driving and ownership experience, tailoring features to consumer preferences and feedback [13].

Battery Management System (BMS) Optimization

Simulations are used to test and refine BMS algorithms, which are critical in managing battery health, state of charge, state of power, and ensuring battery longevity and safety in EVs” [14].





METHODOLOGY

“Creating a MATLAB simulation for electric vehicles (EVs) involves several steps, typically focusing on different aspects like vehicle dynamics, battery performance, motor control, and energy consumption. Here's a high-level breakdown of what you might include in an EV simulation in MATLAB [15-16].

Step-by-Step Guide to Create an EV Simulation in MATLAB:

1. *Vehicle Dynamics Model*
2. *Electric Motor Model*
3. *Battery Model*
4. *Regenerative Braking System*

Simulation in Simulink

“For a comprehensive simulation, use Simulink to create block diagrams for each subsystem:

- **Vehicle Dynamics:** A subsystem with inputs like throttle, brake, and road conditions [17].
- **Motor Control:** A block that models the torque-speed characteristics of the motor [18].
- **Battery System:** A block that tracks SoC and delivers current to the motor [19].
- **Driver Model:** Simulate driver inputs like speed control and braking [20].

Simulink provides built-in blocks for many of these systems, and you can use **Simscape Electrical** for detailed EV models, including battery and motor dynamics” [21-22].

RESULTS AND DISCUSSION

MATLAB Code for Vehicle Dynamics

Vehicle Subsystem:

- “Use blocks to represent the forces acting on the vehicle.
- Add integrators to calculate vehicle velocity and displacement” [23].

The MATLAB code for vehicle dynamics is presented in Fig. 1

MATLAB Code for Motor Torque

“An electric motor's performance can be represented by its torque-speed characteristics” [24]. The power P_m and torque T_m are related as: $T_m = (P_m) / \omega$

Where ω is the angular speed in (rad/s).

Figure 2 demonstrates the MATLAB Code for Motor Torque

MATLAB Code for Battery Model

Battery Model: The battery provides power to the motor [25]. The State of Charge (SoC) can be modeled using the battery current as shown in Figure 3.

Regenerative Braking System

“Regenerative braking recovers energy during deceleration. A simple model might assume a fraction of the braking energy is returned to the battery and the MATLAB Code [26]” is presented in Figure 4.

Applications of Simulation in Electric Vehicles

Battery Simulation:

“EV batteries are simulated to analyze various factors like thermal management, charging and discharging cycles, aging, and energy density. This helps in developing more efficient and safer batteries.

Power train Simulation:

Simulating different types of electric drive trains (motors, inverters, and gear systems) allows engineers to understand power delivery, torque distribution, and efficiency under various driving conditions.



**Deepak Kumar et al.,****Energy Consumption and Range Prediction:**

Simulations can predict energy consumption for different driving patterns and environmental conditions, which helps improve the accuracy of range estimations and optimize energy usage.

Thermal Management Simulation:

Managing heat generated by the battery and power electronics is crucial for safety and performance. Simulations help design efficient cooling systems that maintain the ideal operating temperature for EV components”.

Vehicle Dynamics:

“EV simulations allow for the study of vehicle behavior, such as handling, braking, and acceleration, under various conditions. This leads to safer and more efficient vehicle designs.

Charging Infrastructure Simulation:

Simulating the interaction between EVs and charging stations, including wireless or fast-charging technologies, helps optimize the infrastructure for EV deployment and reduces charging times.

Autonomous EV Development:

Simulations are extensively used in the development and testing of autonomous electric vehicles. They help test sensors, control algorithms, and decision-making software in a controlled virtual environment.

Regenerative Braking Simulation:

Engineers use simulation to optimize regenerative braking systems in EVs, maximizing energy recovery during braking and enhancing overall vehicle efficiency.

Manufacturing Process Simulation:

Simulations are used to optimize the manufacturing processes, ensuring efficient production, minimal waste, and quality control for EV components like batteries and motors.

Environmental and Policy Simulation:

Urban planners and policymakers can use simulation to model the impact of large-scale EV adoption on infrastructure, power grids, and the environment, aiding in decision-making for future transportation systems”.

CONCLUSION

- “By leveraging Simulation technologies, the development of electric vehicles becomes more efficient, cost-effective, and aligned with sustainability goals, leading to better performance and user satisfaction in real-world applications.
- There are several specialized software tools for Electric Vehicle (EV) simulation, each serving different aspects of EV design, development, and performance optimization. These tools can simulate various components such as the electric power train, battery systems, energy consumption, and thermal management.
- Some of the best software tools commonly used for EV simulation is MATLAB/Simulink.
- MATLAB/Simulink is a versatile platform for simulating EV components such as power electronics, motors, and batteries. It offers pre-built libraries for modeling EV dynamics, Battery Management Systems (BMS), and electric drive trains.
- Engineers can also develop algorithms for energy management, regenerative braking, and charging control.
- Basic MATLAB/Simulink example of an EV simulation models vehicle dynamics, motor performance, battery depletion, and regenerative braking. This can be expanded into a more detailed model using Simulink's advanced toolboxes such as Simscape for accurate EV simulation”.

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```

matlab

% Vehicle Parameters
m = 1500;           % Mass of the vehicle in kg
Cd = 0.3;           % Drag coefficient
A = 2.5;            % Frontal area in m^2
rho = 1.225;        % Air density in kg/m^3
Cr = 0.01;          % Rolling resistance coefficient
g = 9.81;           % Gravitational acceleration in m/s^2
theta = 0;          % Road slope angle in radians
v = 0;              % Initial vehicle velocity in m/s

% Simulation Time
t_sim = 100;        % Total simulation time in seconds
dt = 0.1;           % Time step
time = 0:dt:t_sim;  % Time vector

% Assume constant traction force for simplicity
F_traction = 2000; % Traction force from motor in Newtons

% Net force and acceleration
F_net = F_traction - F_resist;
a = F_net / m;

% Pre-allocate variables
v_hist = zeros(1, length(time)); % Velocity history

% Update velocity
v = v + a * dt;

% Store velocity history
v_hist(i) = v;

end

% Loop through each time step
for i = 1:length(time)
    % Forces acting on the vehicle
    F_aero = 0.5 * Cd * A * rho * v^2;
    F_rolling = Cr * m * g;
    F_grade = m * g * sin(theta);

    % Total resistive forces
    F_resist = F_aero + F_rolling + F_grade;

    % Plot vehicle velocity over time
    plot(time, v_hist);
    xlabel('Time (s)');
    ylabel('Vehicle Velocity (m/s)');
    title('Vehicle Velocity Over Time');
    grid on;

```

Figure 1: MATLAB Code for Vehicle Dynamics





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```

matlab

% Motor Parameters
P_m = 75000;      % Motor power in watts (75 kW)
efficiency = 0.9; % Motor efficiency (90%)
v_wheel = v;      % Wheel velocity in m/s
r_wheel = 0.3;    % Wheel radius in meters

% Angular speed of the wheel
omega_wheel = v_wheel / r_wheel; % rad/s

% Torque from the motor
T_m = (P_m * efficiency) / omega_wheel;

```

Figure 2: MATLAB Code for Motor Torque

```

matlab

% Battery Parameters
C_b = 60;      % Battery capacity in Ah
V_b = 400;     % Battery voltage in volts
P_batt = P_m;  % Power demanded by the motor
I_batt = P_batt / V_b; % Battery current

% Initial SoC
SoC = 100; % Initial state of charge (%)

% Update SoC over time
SoC_hist = zeros(1, length(time));
for i = 1:length(time)
    % Update SoC based on current draw
    SoC = SoC - (I_batt / C_b) * (dt / 3600); % Convert to hours
    SoC_hist(i) = SoC;
end

% Plot SoC over time
figure;
plot(time, SoC_hist);
xlabel('Time (s)');
ylabel('State of Charge (%)');
title('Battery State of Charge Over Time');
grid on;

```

Figure 3: MATLAB Code for State of Charge (SoC)





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matlab

```
% Regenerative Braking Parameters
regen_efficiency = 0.7; % 70% energy recovery during braking

% If decelerating, apply regenerative braking
if a < 0
    P_regen = -F_net * v * regen_efficiency; % Power recovered
    I_regen = P_regen / V_b; % Current back to battery
    SoC = SoC + (I_regen / C_b) * (dt / 3600); % Update SoC
end
```

Figure 4: MATLAB Code for Regenerative Braking System





Ramsagar Rice Cultivation: Sustainable Practices for Maximizing Yield, Quality, and Nutritional Value

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ABSTRACT

Ramsagar rice is a traditional variety cultivated in India and is famous due to its toughness and flavor. This paper describes the various management practices, suitable soil types and pH, method of fertilization, indicators of maturity, and methods of handling ramsagar rice after harvesting. It is suitable for clayey and loamy soils and moderate acidity of 5.5pH- 6.5 pH though it can adapt slightly acidic to alkaline soils. Plant and row spacing of 20-25cm between rows and 10-15 cm between plants allows the plants to establish well and compete for the available resources minimally. The use of fertilizers is important in increase yield, organic manure like FYM increases the fertility of the soil and the chemical fertilizer likes N, P and K provide nutrient at different growth phases. Ramsagar rice generally takes 120 to 140 days to mature and this is harvested when 80-85 percent of the grains turn from green to a golden yellow color with the 20- 22% moisture content. Post harvesting practices like drying and threshing, cleaning and storage should be well done to promote grain quality and minimize on grain loses. Drying on the other hand assist in reduction of moisture content within the rice to below 12% so as to avoid spoilage to rice and on the other hand careful milling does not reduce most of the nutritional value associated with the rice. It also emphasizes on a standpoint that it is more advantageous to go for conventional approaches along with integration of improved technologies for ramsagar rice farming. By adopting efficient irrigation schedules and nutrient management practices, farmers can optimize water use and improve crop yields. The above information can be helpful for the farmers, agriculturalists and the policy makers who deals with the production & publicity of Ramsagar rice a quality rice with improved nutritional value but keeping its original form.



**Chandaka Deepthi and Shyamala Alana Teja****Keywords:** Ramsagar, Rice, Yield, Soils, Nutrition

INTRODUCTION

Indian traditional variety ramsagar rice has caught attention for its strange features, nutritional values, and strength against dissimilar climatic conditions. Rice is the staple of millions, especially in Asia, constituting a considerable proportion of daily caloric intake. Among thousands and thousands of types of rice grown over the subcontinent, this one stands out uniquely in its resilience, flavor, and historical credentials.

Importance of Ramsagar Rice

However, analysis made in this paper has attempted to do this, Ramsagar rice is not only a mere food and is the food that is emblematic of the social change of rural society. This variety is of great importance to the smallholder farmers since as it is not only a source of food for their families but also income from market sale. Unlike many modern high yield varieties Ramsagar rice is usually grown through practice of organic farming, this efficiency helps in reducing on use of on chemicals and synthetics and promotes use of ecological farming. Additionally, Ramsagar rice has a distinct taste and it also has a distinctive odour which is also a boost in its sale ability in the various uses it is prepared for. Singh, P, & Gupta, A. (2017); Kumar, V.& Yadav, S. (2020).

Historical Background

Ramsagar rice is one of the oldest types of rice which are been grown by the Indian farmers for generations now. It is being grown and used in a way that it even enhances cultural practices and hence cultural welfare given by Roy, B. & Banerjee, S. (2018). In recent years, however, hybrid rice varieties have been developed for even higher yields and shorter maturity period and hence the local varieties such as Ramsagar is in jeopardy given by Patel, R., & Mishra, A. (2021) and Ahmed, S., & Sharma, P. (2018). However, the use of heritage rice varieties has faced some difficulties lately thus, people have initiated attempts to restore its use, emphasizing the nutritional value of this product and usefulness in organic farming.

Nutritional Benefits

Ramsagar rice contains essential nutrients that make it very important in diets all over the world. That is why it is imperative to note that Ramsagar rice is not packed with starchy content by any means, and many modern rice varieties are actually developed with the least amount of fiber, vitamins, and minerals possible. Light GI is preferred because it helps regulate the level of sugar in the body, therefore is appropriate for users with diabetes. Also, the variety is normally grown without synthetic fertilizers and pesticides which make it even more popular not only because it is healthy but is organic too. Ramsagar rice supplementation to diets can benefit health in eating patterns especially among rural clients who depend on rice as their staple food. Reddy, P. & Verma, N. (2020).

Health Benefits of Ramsagar Rice:

Rich in Nutrients: Based on nutritional value of many traditional rice varieties Ramsagar rice may contain high amount of carbohydrates vitamins (B group) and minerals such as magnesium, potassium and phosphorus which play role in energy production and bone strength.

High Fiber Content: Therefore, in terms of amount of dietary fiber content, the proposed Ramsagar rice might be similar or even somewhat superior to at least some of the contemporary rice varieties if adopted as whole-grain or unprocessed grains. Fiber is reputed to boost digestive health, decrease the occurrence of constipation, and help in better glycemic control.

Low Glycemic Index (GI): Many traditional varieties of rice such as Ramsagar have a relatively low glycemic index as compared with hybrid or modern varieties, which produce a gradual, prolonged flow of glucose into the blood stream. This makes it perfect for every diabetic patient and anyone who would wish to have low blood sugar levels.



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Antioxidant Properties: They may therefore be assumed to have natural antioxidants like phenolic compounds which helps in some conditions like oxidative stress inflammation thus have an effect in disease prevention like heart diseases certain types of cancer among others.

Supports Heart Health: In addition, availability of Kota and Maganese in the Ramsagar rice also has a motivation for the improvement of blood pressure which will go a long way in the prevention of heart diseases. Also, certain whole grain varieties of this rice might reduce cholesterol levels, thanks to the fiber.

Sustainable and Organic: Ramsagar rice is low irrigation rice which is developed organically without using chemical fertilisers and pesticides during its production. This minimizes dangers of working with hazardous substances, and where applicable, most of the food people use and produce locally is fresh, healthy and grown naturally Choudhary, R., & Rao, K. (2020).

Allergen-Free and Gluten-Free: Like other rice brands, Ramsagar belongs to the milk rice and it has no component of gluten which makes it fit for people who have gluten intolerance or those who have Celiac disease, Ramesh, R. & Gupta, S. (2021).

Energy Booster: Due to its carbohydrate content Ramsagar rice is very ideal for use especial by the sporting disciplines, energetic persons and those who would wish to have a steady source of energy throughout the day.

Climate Requirements

Therefore, the climate for Ramsagar rice production needs to be set in order for the cultivate the produce. This variety is best suited for warm temperature, places with relatively high rainfall and moderate sunlight. It is most suitable for countries that lie within the tropic and sub tropics or the region that is characterized by temperatures of between 20 and 35° C. Rice crops do well under conditions where there is well defined monsoon that provides the rains. But, Ramsagar rice also benchmarked its performance even in the condition of minor drought which can attract the farming community, who are more vulnerable to climate change.

Soil and pH Requirements

Soil health is paramount for successful rice cultivation, and Ramsagar rice is no exception. This variety flourishes in clayey and loamy soils with good water retention capacity. The ideal soil pH ranges from 5.5 to 6.5, although Ramsagar rice can tolerate slightly acidic to alkaline conditions. Soil fertility can be significantly enhanced through the application of organic manures, which improve soil structure and nutrient availability. Understanding the specific soil and pH requirements is essential for farmers to achieve optimal yields and maintain soil health.

Ramsagar has characteristics of a traditional long duration rice variety different from today's high yielding hybrids that have relatively short growing periods. They are not as chemical intensive and, in most instances, are more responsive to traditional techniques of farming. But the Ramsagar rice variety yield is comparatively lesser due to which farmers avoid its cultivation and more focus on modern hybrid types of rice. Sharma, P. & Yadav, M. (2019); Singh, H. & Gupta, P. (2021); Verma, S., & Singh, P. (2020). Ramsagar rice has more protein and fiber content as compared to the modern HYVs types of rice. It also has proven to contain higher levels of micronutrients such as the Iron, Zinc which may assist to eliminate the vice of malnutrition in the third world region. Lacking the strong smell typically found in Basmati rice, Ramsagar rice is the rice of choice with normal nutritional value for daily meals. Chatterjee, S. & Roy, A. (2019); Prasad, N. & Yadav, R. (2021).

Ramsagar rice is a land race type which has developed under a particular ecological factor. This is very beneficial for rice diversity because it helps to improve the plant resilience to changes in climate, pest and diseases. Modern hybrid varieties, despite being bred for high productivity and disease resistance, come with their uniform gene pool which creates problems such as vulnerability to emerging factors such as climate change and new diseases. The cultivation of Ramsagar rice is in consonance with the aims to save rice seed variety for food security measures and safe earth causes. But Ramsagar rice remains fluffy, non-sticky, with its high amylose content and has separate grains even after being cooked which makes it ideal for dishes where grains need to be pronounced. It has a high gelatinization temperature; hence, it takes longer time in the cooking process and is not suitable for the short cooking process in the new improved hybrid varieties.



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Ramsagar rice is traditionally grown through low input, especially adopting organic methods hence retaining fertility of the soil with negligible impact on the environment. In contrast, modern hybrids are almost fully reliant on chemical fertilizers and pesticides, which decrease the nutrient potential of the soil and impact the bio-diversity of the areas raising, therefore, the question of genetic uniformity. Ramsagar rice is more ecological than other rice varieties hence suitable for cultivation in areas of conservation.

Cultivation Practices

Proper cultivation techniques would optimize the potential of Ramsagar rice. Some of these proper cultivation techniques include appropriate sowing, the right management of irrigation, and pest control. Other traditional approaches like transplanting seedlings rather than direct seeding ensure a strong establishing force of the plant. Further, the spacing of plants and rows is done such that there is no interference between plants for obtaining nutrients and light. Yet another critical factor is irrigation as proper availability of water at the critical stages of growth is likely to impact both yield and quality of grain. Yadav, M. & Singh, H. (2021).

Challenges in Cultivation

Nevertheless, the following are among the challenges that Ramsagar rice farmers faced while growing this rice. Because of these increased yields from hybrid varieties coupled with agricultural policy changes, the area allocated to growing ordinary rice has reduced in the last couple of decades. Also, climate change results in high risks such as forecast of rainfall and frequent development of pest and diseases. Das, A. & Roy, B. (2020) and Sen, A., & Roy, D. (2020). Farmers may not know how to practice environmentally friendly production of Ramsagar rice which is something that makes them complicating.

Revitalizing Traditional Varieties

These types of importance to preserve traditional rice varieties have urged many organizations and initiatives to come forward and encourage the cultivation of Ramsagar rice varieties. This will rise the interest of farmers in new and exclusive traditional farming practices and nutritional benefits of heritage rice. Local markets are being developed for the promotion of sales of Ramsagar rice, to bring farmers close to those consumers who have a desire to consume these kinds of rice. Cultivating Ramsagar rice will effectively encourage the development of biodiversity and sustainable agricultural production among communities.

Potential Regions in India for Ramsagar Rice Cultivation

Ramsagar rice grows with unique climate condition and, thus, many regions in India have the potential to grow Ramsagar rice. Singh, H. & Gupta, S. (2020). These areas have a tropical and subtropical climate, with sufficient rainfall and appropriate soil types. Out of the reasons suitable for growing Ramsagar rice, these are below:

West Bengal: This state experiences a tropical climate with heavy monsoons, making it one of the most favourable regions for rice cultivation. The state has a vast potential for cultivation of traditional varieties such as Ramsagar rice. It receives about 1200–1500 mm of rainfall a year and still more during monsoon months. The Gangetic plains have alluvial soil that can support rice as the Gangetic plain is the reservoir of water – storing plane.

Odisha: Climate in Odisha is subtropical, hot and humid and has heavy monsoon influence depending on the season with a rainfall of 1200–1600 mm rainfall per year, perfect for rice cultivation. Coastal regions are more suitable for cultivation due to clay and loamy soils.

Bihar: The climate of Bihar is tropical with well-defined monsoons as rice needs them to get its correct amount of water. This state receives rainfall of 1000 – 1200 mm annually which is more than enough for cultivation. River Ganges contains fertile alluvial soils suitable for rice farming.

Assam: Organic rice production is suited well in Assam because the climate is high humid and sub-tropical with more rainfall suitable for growing of traditional rice varieties. On an average, the water supply varies between 30 – 60 inches of rainfall per year in Assam in total. Alluvial soil associated with floodplains is appropriate for paddy farming due to the water conservation property exhibited by this type of soil.



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Chhattisgarh: This state is also called the “Rice Bowl of India” due to it has a favourable tropical climate for rice. It receives annual rainfall of 1100-1500 mm well distributed monsoon period is the ideal period for tourism. In the plains, clay and loamy soil has relatively better water holding capacity for paddy field.

Jharkhand: It is situated at tropical region with relatively moderate heavy rainfall for cultivating Ramsagar rice. The annual rainfall is between 1100 - 1400 mm, falling mainly during the monsoon season. The plateau regions can support the production of rice through cultivation since the regions possess certain types of soil that include; deep, well-drained loamy soil.

Uttar Pradesh (Eastern region): The climatic condition found in this region is subtropical with two distinguishable monsoon periods. In the region, the average annual precipitation varies between 1000–1200 millimeters. It is true that rice can be cultivated in alluvial soil of the Ganges plains more specificity focus should be given to Ramsagar local varieties.

Tamil Nadu (Coastal regions): The coastal area of Tamil Nadu has a tropical climate and a dominant crop variety is rice. Although the state is not one of the states with high rainfall and records an average rainfall of one thousand millimeters annually, it has well developed irrigation facilities. Soils are of clayey and loamy types.

Kerala (Lowland regions): It is also just too appropriate for rice cultivation due to high humidity, consistency in monsoon rain of this climatic condition and the place – Kerala. The state on an average receives 2017 mm of rainfall which mostly occurs during SW Monsoon. The alluvial soils that retain water, and clayey paddy fields of lowland South Asia make rice farming perfect.

Andhra Pradesh (Coastal belt): In Andhra Pradesh the coastal region receives about high rainfall and the climate of summer is very hot and humid. It receives an annual rainfall of between 1000-1200 mm. Loamy friable clay soils of the Krishna Godavari delta region of India are highly suitable for paddy fields.

These are some of the areas that are suitable for production Ramsagar rice as the environmental conditions such as temperature, humidity and rainfall and types of soil suitable for growing this traditional but quality rice is adequate.

Manures and Fertilizers**Organic Manures:**

Application of well-decomposed farmyard manure (FYM) or compost at the rate of 5-10 tons per hectare before transplanting is highly recommended. This improves soil structure, moisture retention, and microbial activity. Green manure crops like Sesbania or Dhaincha can be grown prior to rice planting and incorporated into the soil to enrich its organic content.

Chemical Fertilizers:

Nitrogen (N): Ramsagar rice requires a basal dose of 60-80 kg/ha nitrogen, split into three applications (basal, tillering, and panicle initiation stages).

Phosphorus (P_2O_5): 40-50 kg/ha of phosphorus should be applied as a basal dose to promote root development.

Potassium (K_2O): 40-60 kg/ha potassium is required for enhancing disease resistance and grain filling. Potassium should be applied in two doses, basal and at the panicle stage.

Micronutrients: Zinc (5-10 kg/ha) and iron may be supplemented, especially in zinc-deficient soils to prevent chlorosis.

Maturity and Harvesting Indices

Maturity Indices: The rice variety is medium duration in nature and comes to harvesting after 120-140 days from sowing. The actual time period may vary subject to climatic conditions and management practices.

Harvesting Indices: The grains in the panicle turns golden yellow to 80-85% when they are ready for harvest. Grains should be harvested when the moisture content is about 20-22% as well. Late harvesting causes grain shattering and poor harvest. The grains become tough and will no longer be indented when pressed, they start turning yellow as the straw dries up.

Post-Harvest Handling

**Chandaka Deepthi and Shyamala Alana Teja****Drying:**

Grains should be dried immediately following harvest to decrease the moisture content from 20-22 to 12-14%. This could be either sun-dried or by mechanical drying. Drying is another method of food preservation, by decreasing the moisture content of the product through the use of a drying medium such as coal or solar power that prevents spoilage and fungal growth and storage losses.

Threshing:

Threshing by manually or mechanical-thresher to separate grains from straw.

Cleaning and Grading:

Clean the grains to remove any dirt, debris, or immature grains. Grading can be done to ensure uniform size and quality of grains, which fetches a better market price.

Storage:

The grains have to be dried sufficiently in order to store them for a long term, preferably less than 12% moisture content so as to minimize the risk of pests and molds. Keep in a cool dry place away from moisture or abnormal heat source then stored it in air tight container or bag.

Grain storage treatment: Dusting the grains with inert dust or natural preservatives such as neem leaves is known to keep insects away.

Milling:

Although Ramsagar rice is generally machine-milled in small local mill, being a traditional variety, an attempt was made to hand mill it and assess the milling recovery characteristics. However, avoid over polishing to maintain its nutritional value.

Marketing:

Good management practice and storage may also result in Ramsagar rice being rebranded as a premium conventional variety with a hefty price, the study indicated. Packaging with eco-friendly materials and labelling its pedigree, can be further branding of its marketable worth.

Challenges and Opportunities in Ramsagar Rice Cultivation

Even though Ramsagar rice is recognized for its qualities and nutritious value, it has many risks that cause problems for growing and selling the rice. But at the same time, there are many openings that can be used for the improvement of its production and development of the effective agricultural system.

Challenges

Competition with High-Yield Varieties: This type of farming has had a transformation where the farmers adopted the high-yield hybrid rice that takes least time to be produced. Verma, S, & Yadav, M. (2021). This trend always results in the process of dumping local varieties such Ramsagar rice since farmers prefer to grow hybrids that gives them higher returns immediate to the market.

Climate Change: Global warming is still a player that increases impacts that impinge on the performance of agriculture. These are; fluctuation in the length of the rainy season, probability of high temperatures, and shifts in the variability of the weather factors which are a menace to Ramsagar rice production. I only mentioned that such conditions may cause water stress or flooding, which is equally destructive for yield and grains quality.

Pest and Disease Pressure: Heredity resistance of traditional varieties is likely to be lower compared with hybrids when specific pests and diseases are concerned. This can lead to high costs of production and low yields where relevant measures in handling this vulnerability are not employed.

Limited Awareness and Knowledge: Many farmers may lack access to information about best practices for cultivating traditional varieties. This includes knowledge about soil health, pest management, and irrigation techniques. Without adequate training and resources, the potential of Ramsagar rice cannot be fully realized.

Market Access and Infrastructure: Farmers cultivating Ramsagar rice often face challenges in accessing markets. Limited infrastructure for storage, transportation, and processing can lead to post-harvest losses and reduced profitability. Additionally, the lack of branding and marketing for traditional varieties makes it difficult for them to compete in broader markets.



**Chandaka Deepthi and Shyamala Alana Teja****Opportunities**

Growing Demand for Organic and Traditional Foods: As consumer preferences shift towards organic and locally sourced foods, there is an increasing market for traditional varieties like Ramsagar rice. Promoting the health benefits and unique qualities of Ramsagar rice can attract health-conscious consumers and those seeking sustainable food options.

Government and NGO Support: Several initiatives aimed at preserving biodiversity and promoting sustainable agriculture have gained traction in recent years. Government programs and non-governmental organizations (NGOs) often provide support through training, resources, and funding for farmers cultivating traditional rice varieties.

Revival of Traditional Agricultural Practices: There is a growing recognition of the value of traditional agricultural practices that enhance biodiversity and sustainability. By integrating these practices into cultivation, farmers can improve soil health, increase resilience to climate change, and potentially enhance yields.

Research and Development: Investing in research focused on the agronomic performance of Ramsagar rice can yield valuable insights into its cultivation practices and pest management strategies. Developing improved varieties through traditional breeding techniques can enhance resilience while retaining the variety's unique qualities.

Community-Based Initiatives: Building local cooperatives or farmer groups can empower Ramsagar rice cultivators to collectively address challenges related to marketing, knowledge sharing, and resource management. Such community-driven approaches can enhance farmers' bargaining power and improve market access.

Utilization in Specialty Products: Ramsagar rice can be marketed for its unique flavor and nutritional profile, leading to its use in specialty products like artisanal rice dishes, organic rice blends, and health foods. Such niche markets can provide higher profit margins for farmers.

Educational Campaigns: Increasing awareness about the benefits of Ramsagar rice among consumers can drive demand. Educational campaigns highlighting its nutritional value, cultural significance, and ecological benefits can foster a greater appreciation for this traditional variety.

CONCLUSION

Ramsagar rice is a valuable traditional variety that offers several advantages over modern hybrid rice, including superior nutritional content, environmental sustainability, and genetic diversity. Although its lower yield and longer growth period make it less appealing to farmers seeking higher productivity, the renewed interest in organic farming, biodiversity preservation, and sustainable agricultural practices makes Ramsagar rice a viable option for niche markets. With proper conservation efforts, Ramsagar rice can play an essential role in maintaining agricultural biodiversity and promoting food security in the face of climate change.

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Table.1 Agronomic Characteristics

Trait	Ramsagar Rice	Modern Varieties	Hybrid	Other Traditional Varieties (e.g., Basmati, Sona Masuri)
Plant Height	Medium (around 100-110 cm)	Typically, shorter (70-100 cm)		Varies widely; Basmati: 100-120 cm; Sona Masuri: 80-100 cm
Grain Length	Long and slender	Short to medium		Long (Basmati), Medium (Sona Masuri)
Growth Cycle	Longer, 130-150 days	Shorter, typically 90-120 days		Basmati: 140-150 days; Sona Masuri: 120-140 days
Yield	Lower, 2-3 tons per hectare	Higher, 4-6 tons per hectare		Traditional: Varies, often lower than hybrids
Pest Resistance	Moderate resistance to local pests	High pest resistance through breeding		Basmati: Moderate; Sona Masuri: Moderate
Water Requirements	Moderate to high	Higher requirements in most cases		Moderate to high depending on the variety
Fertilizer Dependence	Low to moderate	High, requires intensive chemical inputs		Low to moderate
Environmental Adaptation	Well-adapted to local, traditional farming conditions	Adapted to intensive, high-input farming		Adapted to specific geographic regions





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Table.2 Nutritional Composition

Nutritional Parameter	Ramsagar Rice	Hybrid Varieties (e.g., IR-64)	Other Traditional Varieties (e.g., Basmati)
Protein Content	7-8%	6-7%	7-8%
Fiber Content	2-3%	1-2%	2-3%
Carbohydrate Content	78-80%	82-85%	78-80%
Micronutrients	Higher in iron and zinc	Lower iron and zinc content	High in selenium (Basmati)
Aromatic Compounds	Mild fragrance (less than Basmati)	Minimal or no aroma	Highly aromatic (Basmati)
Glycemic Index (GI)	Medium (55-69)	High (>70)	Low to medium (Basmati: 50-58)

Table. 3 Genetic Diversity and Conservation

Parameter	Ramsagar Rice	Modern Hybrid Varieties	Other Traditional Varieties
Genetic Diversity	High, preserved in local gene pools	Low, genetically uniform for higher yield	High, conserved in local regions
Breeding History	Landrace variety, evolved naturally	Bred for high yields, pest resistance	Traditional varieties maintained by farmers
Disease Resistance	Resistant to local diseases	Engineered for resistance	Varies by variety and region
Climate Resilience	Good resilience to local climate	Adapted to high-input farming environments	Well-adapted to specific microclimates

Table. 4 Physicochemical Properties

Property	Ramsagar Rice	Hybrid Varieties	Other Traditional Varieties
Amylose Content	24-26%	18-22%	Basmati: 22-24%; Sona Masuri: 24-26%
Gelatinization Temperature	High (preferred for certain dishes)	Low to medium (suitable for quick cooking)	Varies; Basmati: Medium
Water Absorption	Moderate	High	High (Basmati), Moderate (Sona Masuri)
Texture After Cooking	Non-sticky, firm	Sticky, soft	Non-sticky (Basmati); Sticky (Sona Masuri)

Table.5 Environmental Impact and Sustainability

Parameter	Ramsagar Rice	Hybrid Varieties	Other Traditional Varieties
Chemical Input Requirement	Low	High	Low to moderate
Water Requirement	Moderate to high	High	Varies
Soil Health Impact	Positive (supports organic farming)	Negative (degrades soil health with inputs)	Positive in traditional farming systems





Unveiling the Role of Plant Epitranscriptomics: Post-Transcriptional RNA Modification in stress Responses and Development

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ABSTRACT

Environmental factors play a key role in plant growth and development. Abiotic factors associate with plant for better sustainability. Sometimes climatic variation and stress condition hinder plant growth and development. Under aggravating condition plant alter their gene sequence without disturbing the nucleotide sequence in DNA and RNA (epigenetics). Epigenetics performs important role in modifications (DNA methylation / histone modification) in gene expression. RNA editing and regulation of gene expression perform by Epitranscriptomics. It is the process of post-transcriptional modification of RNA bases (i.e., cytosine and adenosine methylation). Many types of modification of RNA are done by transcriptomics. i.e., N¹- methyladenosine (m¹A), Pseudouridine (psi), 5-methylcytidine (m⁵c), and N⁶- methyladenosine (m⁶A). These modifications affecting mRNA stability, RNA structure, RNA translation. RNA modification is responsible for plant growth and development and provided the capacity for surviveability hard condition.

Keywords: Stress, epigenetics, stability, Epitranscriptomics, adaptation .

INTRODUCTION

DNA, RNA, and protein plays vital role in transcription, translation, and other activities but also responsible for the gene expression. RNA editing is possible by Epitranscriptomics and it affects the mRNA function. It is responsible for modification of RNA i.e.- N¹-methyladenosine (m¹A), pseudo uridine, 5-methylcytidine(m⁵C) and N⁶-methyladenosine(m⁶A). It leads to structure of RNA, stability of mRNA. According to kumar and Mohapatra,





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2021;selmi *et al.* 2021 the RNA modification affects in the molecular and cellular level in plant. Such as splicing, mRNA export etc. It also plays a vital role in plant development such as flowering, fruiting, trichome development and adaption to stress.

Post transcriptional modification in plant biology

Plants growth and development involves the changes in the expression of genes. The changes are regulated due to the several post transcriptional modification of mRNA. Methylation(m⁶A) is the key factors which is responsible for the modifications in plants. It is important for the growth of the embryo, development of different stages of plant, for root growth and vascular system development is involved. m⁶A stabilizing mRNAs by gene expression. Changing of gene expression helps for the adaption of plant during stress condition. After post transcriptional modification some mRNAs are highly affluence and translated into protein and plays a vital role in the process of photosynthesis and respiration, It also help for the stability of mRNA.

Key RNA Modification in Plants

Modifications play an important role for the betterment of plants and animal. It able to provide the new developing characters, changeness, disease free organism, adaptive property etc. like that RNA modification play a key role in the field of genetic modification in plants. Some important RNA modification involve in plant that are N⁶-methyladenosine (m⁶A) 5-methylcytosine (m⁵C) and pseudouridine.

N⁶- methyladenosine and its diverse effects on RNA function

Post transcriptional modifications play critical role in cellular and developmental process in plants. 160 RNA modification is there through N⁶-methyladenosine (m⁶A) is the most important internal modification on mRNA. It is found in plants, virus, mammals, yeast and insect. M⁶A performs activities like methyltransferase, dimethylases and to deposit, remove and interpret m⁶A on target transcripts.

Role of m⁶A in plant development

The m⁶A writers, erasers or readers play an important role in the developmental process of plant. Its act mainly upon the dividing tissues like in embryo, in meristemic tissue such as root and shoot tips, in young leaves. Basically it is found in the lateral, apical, and intercalary meristematic region in plants. Stress is the biological process of environment. It leads to development of plant adaptivity condition. M⁶A writer play significant role in Arabidopsis in response to biotic and abiotic stresses. It is found that it develops long term salt stress response and adaptation ECT2 is cytoplasm localized found in normal conditions but it relocates to stress granules (SGS) in the condition of heat or drought stress.

5- methylcytosine (m⁵C) as a regulator of RNA metabolism:

M5C assumes a significant part in the parts of RNA handling including tRNA stability, rRNA gathering and mRNA translation. The m5C is recognized by a few strategies like RNA bisulphite sequencing, immunoprecipitation-based identification techniques, liquid chromatography-tandem mass spectrometry and third era sequencing. The contribution of m5C adjusted area found at the intersection of variable circle and the T stem-loop in tRNA. M5C alteration in rRNAs are situated in 18s rRNAs and 25srRNAs. It is found mostly in 3' untranslated district or close to interpretation start sites in mRNAs. M5C alterations additionally happen in long non-coding RNAs, circular RNAs, small nuclear RNAs and small nucleolar RNAs. m5C adjustment is controlled by a few proteins like 'journalists', 'perusers', and 'erasers'. The m5C change assumes a crucial part in stress response, incipient organism and organ improvement in plants.

Pseudo-uridine and other modifications impacting plant gene expression:

Pseudouridine modification is the abundant modification of RNA. Pseudouridine is the first post transcriptional modification. First time pseudouridine modifications found in the Arabidopsis. It is present in mRNA in yeast, mammals, and the parasite *Toxoplasma gondii*. Pseudouridine modification is distributed in the region of rRNA,



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tRNA and other non-coding RNAs. It performs the activity of stabilization of RNA structure, ribosome biogenesis, rRNA processing, Pre-mRNA splicing and protein synthesis, development, and response to stress.

Epitranscriptomics in stress responses:

Plants depend upon the climate and abiotic factors for their growth and development. Pollution level is increasing now a days, it leads adverse condition. Pollution is responsible for the unwanted climatic change. The climatic change affect the plant growth and it reduce the yield. It creates a altered environment which leads to abiotic stresses such as high temperatures, drought, high salinity as well abiotic stresses such as insects, microorganisms and viruses. To adapt or survive in adverse condition post transcriptional modification, expression of gene plays an important role molecular level in plants. It involves DNA methylation, histone modification and a series of RNA modification. Post transcriptional modification of mRNA(epitrancriptomic) is plays a vital role in plants with response to biotic and abiotic stress. Till now 160 diverse RNA modifications are identified. Among over N⁶-methyladenosine(m⁶A), N¹-methyladenosine(m¹A) and 5-methylcytidine(m⁵C) are abundant internal modifications found in coding RNAs. M6A and m5C are crucial alteration in eukaryotes. Cell parts are engaged with these alterations incorporate methyltransferases (as 'writers'), demethylases (as 'erasers') and RNA-restricting proteins (as 'readers'). The alteration of m6A and m5C in plants perform with reaction to abiotic and biotic pressure. It is answerable for the stability and translation of mRNA under stress condition. The m6A is re-limited from the cytoplasm to the stress granules under heat shock. The m6A marks shift inside a similar record and the m6A is rearranged on new transcripts under pressure.

Here different plant species goes through various stresses and alteration required by m6A and m5C. m6A alteration associated with arabidopsis plant under salt stress and multi week old rosette leaves tissue is utilized for the sequencing. In rice plant roots and shoots tissue is utilized for sequencing. Roots tissue is utilized for sequencing in sweet sorghum plants. Under drought stress one year old seedlings leaves tissue of apple plant is utilized for sequencing. The ocean buckthorn plant under drought stress sequencing happen by utilizing blend of leaves and stems and roots tissue. Five leaf stage seedlings tissue is utilized for sequencing in pak-choi plant species under heat stress. In tomato anthers is utilized for sequencing in temperature stress. The rice plant goes through biotic pressure like RSV, RBSDV stress and here seedlings tissue is utilized for sequencing. The m5C alteration required under heat stress in rice plant and multi week old seedlings tissue is utilized for the sequencing.

Climate change is very much responsible for the unfavourable condition which leads to plant stress. The stress may be biotic and abiotic stress Abiotic stress include drought, salinity, and temperature stress are major environmental factor which disturb the cellular metabolic process in plants. It affects the yield capacity, sustainability. The plants with poor stress resistance need more water and fertilizer which is harmful for the environment. In response to stress plants generated signalling which provide resistance against the stress. The stress signal causes a change in cellular component and change other cellular component activities. The stress induced changes found in protein and other cell organelles such as chloroplast, mitochondria, peroxisome, nucleus, and cell wall and the stress generated signals from all organelles regulate stress responsive gene expression to restore cellular homeostasis. The important stress signalling pathway are ABA, Brassinosteroid.

Epi-transcriptomic and Hormone Signalling

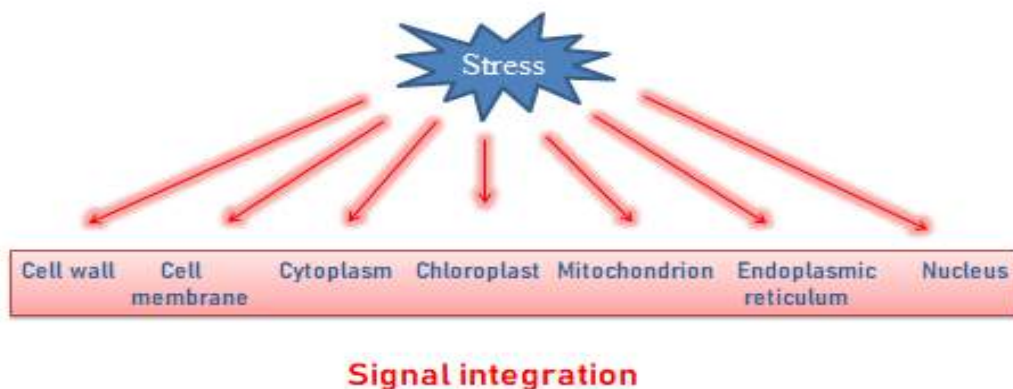
RNA modifications assume an essential part in the biosynthesis of chemical and its guideline. hormone signalling happens with reaction to abiotic and biotic stress. Movement of hormone is directed by its bio accessibility and impacted by its biosynthesis individual biosynthesis of various hormone happen and co-ordinate with one another for a particular reaction. In rice plant (*Oryza sativa*) biosynthesis of various hormone happen and cross talk among hormone biosynthesis pathways found at the transcriptional level with reaction to abiotic stress and microbe. Biosynthesis of chemical is a complicated organization, where one hormone is impacted by a few hormones. Abscic corrosive and brassinosteroid direct by cytokinin formation and brassinosteroid biosynthesis is impacted by both abscisic corrosive and cytokinin.





Hormone signalling control the sickness obstruction and abiotic stress reaction in rice plant. hormone, for example, salicylic acid (SA), jasmonic acid (JA), ethylene(ET), brassinosteroid (BR) and Absciscic acid (ABA) interact decidedly and adversely. ABA is Gibberellic corrosive suppress stress reaction. Auxin suppress safeguard against microorganism yet advances abiotic stress resistance. Cytokinin interfaces adversely with ABA, JA, and BR. Post transcriptional modification of mRNAs, plays an important role in the growth and development of plants. Modification occurs in specific set of mRNAs and may be found in specific sequence contexts. N⁶-methyladenosine(m⁶A) is the abundant internal modification in plant mRNAs and it is responsible for the embryonic, post embryonic and different stages of plant growth and development. M⁶A is found in the 3'UTRs of plant mRNAs and it is deposited by methyltransferase complex whose activity is coupled to transcription. For the gene regulation of m⁶A in plants involve specialized RNA binding proteins with an m⁶A recognizing YTH domain. Three of these proteins (ECT2/ECT3/ECT4) exhibit apparent genetic redundancy in m⁶A dependent control of leaf growth and development 5-methylcytidine (m⁵C) promotes phloem transport of mRNA in plants.

The apparatus of RNA alterations is found between the rice plant and viruses. m⁶A is the significant modification that shows noteworthy outcome in the rice plant against virus. The m⁶A methylomes in rice plants defiled with two devastating viruses. The m⁶A methylation is fundamentally associated with that characteristics are not imparted in contamination polluted rice plants. The m⁶A allocation is moreover found in a comparable quality, which incorporate the antiviral modes between rice stripe infection or rice dark stripe bantam virus sickness. The discernment shows that the level of m⁶A methylation is growing in rice plants with response to virus tainting. The m⁶A methylated control a couple of antiviral pathway related characteristics, for example, RNA silencing, impediment and significant antiviral phytohormone metabolic related qualities. The m⁶A changes overwhelmingly deal with the qualities of genes.



RNA Modification Enzymes Writer, Reader, and Erasers

Enzyme are proteins and also called as biocatalyst for modifications of RNA mainly 3 enzymes are responsible i.e writer, reader, and eraser which can for deposition/ install, recognition and remove the modification. M⁶A on mRNA and m⁶A demethylases which will remove the marks. The essayist complex is known to contain the methyl transferases METTL3 and METTL14 the METTL3 connector WTAR and other related proteins including KLAA1429, RBM15/15B, and ZC3H13. In the METTL3 goes about as the synergist subunit, while METTL14 offers a RNA restricting framework, enacting and upgrading the reactant yet cooperates with METTL3 and METTL14 to balance the m⁶A levels of RNA records. Both METTL3 and METTL14 assume fundamental parts in different natural cycles including undeveloped turn of events. The evacuation of m⁶A is known to be done by two distinct compounds FTO and ALKBH5. Anyway FTO has been found to specially demethylate m⁶Am a m⁶A related, exceptionally bountiful nucleotide in mRNA. This finding proposes that ALKBH5 might act as the major m⁶A demethylase. M⁶A 'perusers', intercede the downstream impacts of this unmistakable mRNA alteration m⁶A advances the commencement of interpretation through the m⁶A peruser protein YTHDF2. Because of intensity stress m⁶A methylations inside the 5'UTR of mRNAs are safeguarded from FTO intervened demethylation by the limiting of YTHDF2 and work with





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cap-free translational inception. What's more, a solitary m6A buildup inside the 5'UTR empower the interpretation of an uncapped mRNA, possibly through the particular restricting of the inception factor eIF3. Interpretation inception is additionally managed through YTHDF1. YTHDF1 specifically peruses m6A destinations situated close the 3' finish of mRNAs and advances the interpretation of the separate mRNA through an association with the ribosomal commencement complex. While the m6A peruser proteins YTHDF1 and YTHDF2 both advance interpretation by working with the rate restricting step of translational inception, YTHDF2 likewise decides the lifetimes of a mRNA by overseeing it to mRNA rot locales. RNA binding proteins play a key role in the posttranscriptional modification of RNA. It control the activity such as translation, export, localization, splicing, and degradation of mRNA. NP13, a yeast SR protein which interact pre- mRNA and regulate all the event from splicing to translational elongation. Several proteins are there which play a specific role in mRNA processing. Tap protein which like its yeast homolog mex67 involve in export mRNA from the nucleus to cytoplasm. RNA binding protein contain several domains which help in binding the target RNA, most common domains are the RNA recognition motif (RRM), hnRNP K homology domain (KH) and the plasticity in controlling gene expression it involved in the regulation of embryo development in *Caenorhabditis elegans*, T-cell activation etc.

Technological insights into Epitranscriptomics

In Epitranscriptomics high throughput sequencing and transcriptome wide mapping of RNA modification are important techniques. It studies about the chemical modifications to RNA molecule. These modifications involve in the activity of RNA stability, processing and function. Researchers use various sequencing methods, such as meRIP-seq (methylated RNA immune precipitation sequencing) or m⁶A-seq (methylated RNA immuno precipitation and sequencing), to map and analyse RNA modifications at a transcriptome wide scale in plants and other organisms. It provides the regulatory roles of RNA modifications in gene expression stress responses and development in plants. High throughput sequencing generates vast amounts of data specialised bioinformatics tools are used to analyse and interpret the results, identifying modified RNA sites. Single molecule sequencing approaches helps to study modification dynamics in DNA and RNA. Its ability is to observe individual molecules, which can be crucial for understanding epigenetic modification, RNA modification. Some important single molecule sequencing methods used for resolving modification dynamics include-

Nanopore sequencing Oxford Nanopore and different stages empower the direct sequencing of RNA particles. These innovation can recognize altered bases by estimating changes in electrical flows as RNA goes through nanopores. It gives continuous data about RNA adjustments.

- **pacBio SMRT sequencing:** Biological sciences single particle constant (SMRT) sequencing can distinguish adjusted bases by noticing the energy of polymerase joining during sequencing. This strategy takes into account the discovery of adjustments during RNA combination.
- **Direct RNA Sequencing:** Some RNA sequencing techniques like direct RNA sequencing utilizing reverse transcriptase can catch RNA adjustments directly. Modifications modify the opposite record process, living distinct, foot prints in the sequencing information.
- **Hybrid Methods:** Joining single particle sequencing with others methods like mass spectrometry or antibodies well defined for specific changes can offer exhaustive bits of knowledge into adjustment elements.

A few bioinformatics devices helps for examining the Epitranscriptomics in plants. PEA is a significant R tool kit which serves to examination of plant epitranscriptome information. The PEA tool kit contains a total grouping of capacities expected for read arranging, CMR calling, motif scanning and disclosure and quality reasonable upgrade examination. PEA furthermore takes advantage of for transcriptome scale CMR assumption, with high expectation precision, utilizing the positive models simply learning computation, with addresses that two class request issue by using specific Examples (cmr's), in the shortage of negative model (non-Cmr's). Its application is to anticipate N⁶-methyladenosine (m6A) adjustments in *Arabidopsis thaliana*. The tool kit accomplished 71.6% responsiveness and 73.7% explicitness, which is better than existing m6A indicators. PEA is for the most part material bioinformatics procedure in the field of Epitranscriptomics.



**Ghanishtha Prusty et al.,****Epitranscriptomics and Plant Immunity**

Plants are attacked by many pathogens which effects the growth and development, yield capacity. Pathogens destroyed the immunity system and cause various diseases in plants. The post transcriptional modification(Epitranscriptomics) plays a key role in the plant immune system. The modification of RNA can develop the immunity in plants with response to pathogen. It can regulate the gene expression and function in the immune response of plants. Some important points are:

m⁶A methylation: N6 methyladenosine (m⁶A) adjustment is one of the most well known RNA alterations in plants. It can influence the stability, translation, efficiency, of transcripts, subsequently managing their actions during microorganism associations.

Pseudouridine: Pseudouridine adjustment can affect the design of RNA molecule. This change might contribute the proper folding of RNA molecules in immune responses.

Inosine: Deamination of adenosine is another critical modification. It can prompt changes in codon recognition, potentially influencing the collection resistance receptors in plants.

RNA Altering: This is vital process that considers changes in the nucleotides grouping of RNA. It can differentiate the immune receptor quality collection and impact the particularity of plant safe reactions.

Epitranscriptomics plays a key role in pathogen recognition and modulation. Epitranscriptomic adjustment in have cells can impact how they perceive and answer microorganisms. For example, m⁶A changes can influence the interpretation effectiveness of natural receptors (innate immune receptors) or pathogen associated molecular patterns (PAMPs) recognition receptors. It can regulate the statement of immune related genes. For example , m⁶A adjustments have some control over the declaration of cytokines, interferons, and other insusceptible reaction components. This can influence the strength and timing of the insusceptible reaction to microorganism. Microorganisms, especially infections, can likewise use epitranscriptomic changes to sidestep invulnerable reactions. Some infections encode chemicals that change have RNA to avoid discovery and reaction. This can involved in the antigen presentation like major histocompatibility complex (MHC) genes and it play a part in the improvement of immunological memory. Epitranscriptomics assumes a significant role in the control of small RNAs (sRNA). It involve the regulation of antiviral mechanism including small RNA molecules through the adjustment of RNA particle themselves small RNAs, including micro RNAs and small interfering RNAs (RNAs) assume a significant part in guarding against viral contaminations. These small RNA molecules can target and degrade viral RNA or restrain viral protein expression, there by decreasing viral replication and spread inside a host.

Harnessing Epitranscriptomics for crop improvement

Engineering pressure responsive RNA changes to improve flexibility in plants through Epitranscriptomics is a creative methodology in agricultural biotechnology in molecules associated with stress responses, we might possibly work on plats capacity to endure unfavourable ecological circumstances. RNA molecules are essential for stress reaction in the objective plant species. This could include examining transcriptomic under stress conditions m⁶A or Pseudouridine, that can improve stability, interpretation, different elements of these objective RNAs. Enzyme and proteins that can present the ideal RNA modifications. CRISPR- based advances might be significant for this purpose. The circumstances for changing RNA in plant cells, taking into account factores like dose, timing and area inside the cell. The altered plants execution under different pressure conditions, contrasting them with unmodified partners. Assess the long term effects of the changes on plant development yield and health. Changing the N6-methyladenosine (m⁶A) alteration on unambiguous mRNAs can upgrade their stability and translation, possible expanding the creation of proteins associated with nutrient retention and metabolism using RNA altering innoations like CRISPR- Cas13 to change transcripts, amending mutations that influence supplement handling mutations that influence supplement handling mutations that influence supplement handling or uptake . Tweaking the declaration of small RNAs, for example, microRNAs, that can post transcriptionally control qualities associates with supplement transport and usage. Recognizing epitranscriptomic markers that relate with workedon supplement bioavailability and content, allowing for designated interventions. Epitranscriptomic changes that impact gene expression in crops. It improve traits like yield illness obstruction, and stress resilience. It can give idea about the systems involves for improving protection from and infections. It can assist with enhancing supplement uptake and utilization in crops,





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diminishing the requirement for fertilizers and making forming more practical. Epitranscriptomic methodologies can add to additional reasonable and harmless to the ecosystem agricultural practices.

Ethical considerations and Biosafety

RNA changes assume a critical part on plant well-being and biological system connections. It improve or suppress characteristics in plants. For example, disease resistance, stress resilience or development rates controlling RNA changes can assist with making plants that are stronger to stresses, which can affect crop yields biological system stability controlling RNA alternations in plants raises ethical concerns related to the negative side effects on environments and long term safety of hereditary changed life forms. It can further develop protection from pests or increased nutrients uptake may decrease the requirement for synthetic pesticides and manures, which can have both positive and negative effects on biological systems. Assess the likely ecological effect of epitranscriptomics adjustments in crops. Consider factors for example gene flow potentially negative side effects and consequences for non- larger living beings. Maintain open and straight forward correspondence with stake holders, including farmers, purchasers and administrative organisation, to address concerns and give data about the innovations advantages and dangers. Execute instruments for long- term checking of epitranscriptomic crops adjustments to recognize any unexpected results or issues that might emerge after their deployment. Ensure that the utilization of epitranscriptomic tools conforms to moral principles and relevant guidelines. This might include acquiring important allows and sticking to protected intellectual property rights. Research exercises, particularly including synthetic substances and lab materials ought to be led with thoughtfulness regarding limiting ecological damage. Appropriate removal of hazardous materials and waste is fundamental stay up- to- date with guidelines connected with research including hereditary or molecular changes. Adherence to biosafety and moral standards is essential continuously survey the expected ecological and ethical implications of epitranscriptomic developments and adjust research practices in like manner.

CONCLUSION

Epitranscriptomics is an arising field that focuses on the investigation of chemical changes on RNA particles, which can impact gene expression and ultimately impact plant physiology and crop improvement. On going years have seen the distinguishing proof of various RNA changes, like N⁶-methyladenosine (m⁶A) and 5-methylcytosine (m⁵C). These modifications have been found to assume essential parts in managing quality articulation and plant development and improvement. The discovery of enzymes responsible for adding, removing and perceiving these changes has been a significant breakthrough. Epitranscriptomics has suggestions for crop stress responses. By regulating RNA alterations, plants can change their gene expression to adapt to unfriendly circumstances, like drought, salinity and extreme temperature. This incorporates adjusting RNA alterations to help photosynthesis. Upgrade supplement uptake, and increase disease resistance. Epitranscriptomics can be utilized for accuracy breeding. By choosing or designing plants with specific RNA modifications, breeders can deliver crops with beneficial qualities more efficiently.

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Table-1: List of m⁵C and m⁶A sequence in various plant species under different stresses

Modification	Stress type	Stress	Plant species	Plant tissues used for sequencing	References
M ⁵ C	Biotic stress	RSV,RBSDV	Rice	Seedlings	Zhang <i>et al.</i>
		CGMMV	Watermelon	Seedlings	He <i>et al.</i> 2021
	Abiotic Stress	Heat	Rice	Three-week-old seedlings	Tang <i>et al.</i>
	Abiotic stress	salt	Arabidopsis	Four-week-old rosette leaves	Anderson <i>et al.</i>
				Seven-day-old seedlings	
M ⁶ A			Arabidopsis	Shoots, Roots	Hu <i>et al.</i>
				Roots	
			Rice		Wang <i>et al.</i>
			Sweet sorghum		Zheng <i>et al.</i>





Enhanced Interior Gateway Routing Protocol (EIGRP): An In-Depth Analysis

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ABSTRACT

Enhanced Interior Gateway Routing Protocol (EIGRP) is a sophisticated distance-vector routing protocol created by Cisco Systems, intended to address the shortcomings of conventional routing protocols like RIP while integrating the advantageous characteristics of link-state protocols such as OSPF. This study examines the architecture, operating procedures, and principal advantages of EIGRP. It also analyzes its convergence properties, scalability, and constraints. The protocol employs the Diffusing Update Algorithm (DUAL) for route computation, highlighting its hybrid characteristics that facilitate efficient and reliable routing across extensive industrial networks.

Keywords: EIGRP, DUAL, OSPF, protocol, Cisco system.

INTRODUCTION

The Enhanced Interior Gateway Routing Protocol (EIGRP) is a dynamic routing protocol created by Cisco in the early 1990s as advancement over its predecessor, the Interior Gateway Routing Protocol (IGRP). EIGRP is a hybrid routing protocol that integrates features of both distance-vector and link-state protocols. The primary design objective is to improve scalability, convergence velocity, and network efficacy. EIGRP is appropriate for medium to large-scale networks because of its resource efficiency, rapid convergence, and adaptability in accommodating various protocols (IP, IPX, and AppleTalk). This study offers a comprehensive analysis of EIGRP's characteristics, its operating processes, and the underlying algorithm. Furthermore, we examine the benefits of EIGRP in comparison to other Interior Gateway Protocols (IGPs) like RIP and OSPF, as well as its constraints and difficulties.





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EIGRP Framework

EIGRP is distinct among routing protocols as it is categorized as an advanced distance-vector protocol. While it predominantly utilizes distance-vector methodologies, it incorporates specific features of link-state protocols, enhancing its efficiency and accelerating convergence. It is a classless protocol, signifying its support for Classless Inter-Domain Routing (CIDR) and Variable Length Subnet Masking (VLSM), hence facilitating more efficient utilization of IP addresses.

Terminology of EIGRP

EIGRP employs distinct terminology that sets it apart from conventional routing protocols:

Neighbor: EIGRP routers form neighbor relationships through the exchange of Hello packets, which are crucial for route dissemination.

Successor: The principal pathway to a destination characterized by the minimal path metric.

Feasible Successor: An alternative pathway that can be promptly activated in the event of the successor's failure. Feasible successors are precomputed but remain inactive unless required.

Advertised Distance (AD): The distance to a destination as proclaimed by an adjacent router.

Feasible Distance (FD): The optimal metric for reaching a destination, defined as the sum of the metric to a neighboring node and the advertised distance from that neighbor.

Diffusing Update Algorithm (DUAL)

The foundation of EIGRP's routing efficacy is the Diffusing Update Algorithm (DUAL), which enables routers to effectively compute loop-free routes and achieve rapid convergence. DUAL guarantees that routers retain backup routes (feasible successors) that are readily accessible upon the failure of the primary route. This allows EIGRP to achieve swift convergence without the necessity of recalculating the complete network topology.

EIGRP Metrics

EIGRP employs a composite metric derived from multiple parameters.

Bandwidth: The minimum bandwidth of the route.

Delay: The total delay along the route.

Reliability: The dependability of the connection, determined by past data.

Load: The existing load on the connection.

MTU: Maximum Transmission Unit, but it is infrequently employed in metric calculations.

The standard EIGRP metric equation is:

$$\text{Metric} = (10^7 \text{ Minutes Bandwidth} + \text{Cumulative Delay}) \times 256$$

$$\text{Metric} = \left(\frac{10^7}{\text{Minimum Bandwidth}} \right) + \text{Cumulative Delay} \times 256$$

EIGRP enables routing decisions based on several metrics, in contrast to RIP, which relies solely on hop count.

EIGRP Functionality

EIGRP employs a multi-step methodology to guarantee efficient routing and rapid convergence inside the network.

Neighbor Discovery and Maintenance

The Hello protocol facilitates the discovery and maintenance of neighboring relationships. EIGRP routers transmit regular Hello packets to detect prospective neighbors. When routers concur on specific criteria (such as AS number and authentication), they establish a neighbor relationship and commence the exchange of routing information.

Reliable Transport Protocol (RTP)

EIGRP utilizes the Reliable Transport Protocol (RTP) to guarantee the dependable transmission of routing information. RTP guarantees the reliable delivery of essential EIGRP packets, including updates and queries, through acknowledgment mechanisms. Non-essential packets, such as Hello packets, are transmitted unreliably to minimize overhead.

EIGRP Packet Categories

EIGRP employs multiple packet types for diverse operations:



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Greetings Packets: Initiate and sustain neighborly connections.

Update Packets: Employed to disseminate routing information to adjacent nodes.

Query Packets: Transmitted when a router lacks a viable successor and must seek an alternate pathway.

Reply Packets: Responses to inquiry packets that signify a route's accessibility.

Acknowledgment Packets: Validate the receipt of update, inquiry, or response packets.

Route Computation Utilizing DUAL

DUAL enables EIGRP to rapidly converge without routing loops by maintaining a plausible successor in the routing table, hence assuring swift failover. The procedure entails:

Successor Determination: The path with the optimal metric to a destination is designated as the successor and utilized for traffic routing.

Feasible Successor Identification: DUAL verifies backup routes, termed feasible successors, that satisfy the feasibility condition: the Administrative Distance (AD) of the backup route must be inferior to the Feasible Distance (FD) of the present route.

In the absence of a viable successor, DUAL transitions to an active state and disseminates queries to other routers to identify an alternative route.

Principal Benefits of EIGRP

EIGRP presents numerous benefits that render it advantageous in specific networking contexts, particularly inside Cisco-centric settings.

Rapid Convergence

The DUAL algorithm of EIGRP facilitates rapid convergence upon the failure of the primary route, thereby minimizing downtime and enhancing network dependability.

Scalability

EIGRP exhibits significant scalability owing to its resource-efficient design and capacity to manage extensive routing tables. Its endorsement of VLSM and CIDR enhances its adaptability for contemporary IP addressing methodologies.

Operation without Loops

EIGRP eliminates routing loops, which can impair network performance and reliability, by retaining viable successors and employing the DUAL algorithm.

Diminished Bandwidth Consumption

In contrast to distance-vector protocols such as RIP, which transmit frequent updates of the complete routing table, EIGRP conveys updates solely when there is a modification in the network. This mitigates superfluous traffic and preserves bandwidth.

Support for Multiple Protocols

EIGRP, while predominantly utilized for IP networks, also accommodates routing for additional protocols, like IPX and AppleTalk, which proved advantageous in legacy networks.

Constraints and Obstacles

EIGRP, despite being an advanced and efficient routing technology, possesses certain limitations:

Vendor Dependency

EIGRP was initially a proprietary protocol of Cisco, restricting its application to Cisco devices. Despite EIGRP's subsequent introduction as an open standard, its proprietary beginnings ensure its predominant utilization within Cisco environments.

Complexity

The configuration and operation of EIGRP are more intricate than those of simpler protocols like as RIP. Network engineers require a comprehensive understanding of the protocol to configure and sustain extensive EIGRP networks proficiently.

CPU and Memory Overhead

The DUAL method, although effective, can be CPU-intensive, particularly in extensive networks with numerous routers and lines. Managing an extensive routing table and computing plausible successors necessitates increased processing power and memory.



**Jhansi Rani Ganapa and Gedela Triveni****EIGRP Compared to Other Interior Gateway Protocols****EIGRP versus RIP**

EIGRP achieves convergence significantly more rapidly than RIP, which depends on periodic updates and utilizes hop count as its sole metric.

EIGRP exhibits superior scalability owing to its implementation of a composite metric and its compatibility with CIDR and VLSM, whereas RIP is constrained to smaller networks.

EIGRP's implementation of triggered updates and bandwidth-efficient protocols renders it more efficient than RIP, which transmits updates at regular intervals regardless of changes.

EIGRP versus OSPF

Convergence: EIGRP typically achieves faster convergence than OSPF owing to the DUAL algorithm and the availability of suitable successors.

Complexity: OSPF exhibits greater complexity in its architecture, such as the implementation of areas, in contrast to the flat structure of EIGRP. OSPF is an open standard that is supported by various vendors, in contrast to EIGRP.

The OSPF routing method employs Dijkstra's algorithm to determine the shortest paths, but EIGRP utilizes DUAL for ensuring loop-free routing and rapid convergence.

CONCLUSION

Enhanced Interior Gateway Routing Protocol (EIGRP) provides a balanced routing methodology, integrating the rapid convergence of link-state protocols with the straightforwardness of distance-vector protocols. The utilization of the DUAL algorithm facilitates rapid route computation and failover, while its compatibility with many metrics renders it a versatile choice for extensive networks. Notwithstanding its exclusive roots and certain resource cost, EIGRP continues to be a compelling option for organizations operating Cisco networks. EIGRP is a highly proficient routing protocol, adept at scaling, converging rapidly, and utilizing bandwidth efficiently, making it well-suited for contemporary network situations.

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HR Best Recruiting Practices Using Artificial Intelligence: Revolutionizing Talent Acquisition

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ABSTRACT

Artificial Intelligence (AI) is revolutionizing human resources (HR), particularly in recruitment, making the process more efficient, unbiased, and data-driven. This article explores the best recruiting practices using AI, providing a comprehensive overview of how AI-powered tools enhance talent acquisition. The objective is to analyze how AI can automate repetitive tasks, improve candidate screening, enhance candidate experience, and facilitate data-driven decision-making in hiring. The introduction delves into the evolution of AI in HR, highlighting its potential to streamline recruitment and reduce biases. It emphasizes the growing need for organizations to leverage AI in order to remain competitive in a rapidly changing job market. A review of the literature presents various studies and reports demonstrating the impact of AI in recruitment, focusing on areas such as AI-driven chatbots, candidate sourcing, and predictive analytics. The methodology section outlines a mixed-methods approach, combining quantitative data from industry reports with qualitative insights from HR professionals. The discussion and results demonstrate how AI tools like chatbots, resume parsing, and predictive analytics are effectively utilized in recruitment. Several tables showcase the key benefits of AI adoption, such as reduced hiring time, improved candidate quality, and enhanced diversity. In conclusion, the article highlights that while AI significantly optimizes recruitment, organizations must be cautious about potential challenges like data privacy and algorithmic biases. The study suggests that integrating AI with human judgment creates an ideal balance for effective recruitment practices. Over the past decade, the recruitment landscape has experienced a technological revolution, with Artificial Intelligence (AI) becoming one of the most transformative elements in talent acquisition. The integration of AI in HR practices addresses critical challenges, such as the high volume of applications, unconscious biases, and the time-consuming nature of traditional recruitment methods. As businesses strive to attract and retain top talent, AI offers innovative solutions that streamline the recruitment process, making it more



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efficient, unbiased, and cost-effective. The evolution of AI in recruitment began with simple keyword matching algorithms for resume screening, which evolved into sophisticated machine learning models capable of identifying candidate potential. AI's role has expanded beyond automating administrative tasks to providing predictive insights about candidate suitability, future performance, and cultural fit within an organization. AI's adaptability and learning capabilities enable recruiters to make data-driven decisions, leading to improved hiring quality and reduced turnover rates. The rise of AI-driven recruitment tools aligns with broader trends in digital transformation, as organizations increasingly recognize the importance of leveraging technology to stay competitive. For instance, AI-powered tools can analyze extensive candidate data, such as employment history, educational background, skills, and social media presence, to generate a holistic candidate profile. This capability allows recruiters to gain deeper insights into candidate potential, which is crucial for roles requiring niche skills or high levels of expertise. Another significant aspect of AI's influence on recruitment is its ability to enhance diversity and inclusion. Traditional hiring processes are often influenced by unconscious biases that can disadvantage certain candidates. AI-driven tools, when correctly designed and implemented, can help minimize these biases by focusing on objective criteria, such as skills, experience, and competencies. This ensures that candidates are evaluated based on their qualifications, leading to a more diverse and inclusive workforce. However, the integration of AI in recruitment is not without its challenges. Concerns around ethical implications, data privacy, and algorithmic biases have sparked debates about the responsible use of AI in hiring practices. While AI has the potential to minimize human biases, it is not immune to the biases present in historical hiring data. This underscores the need for continuous monitoring and evaluation of AI algorithms to ensure fairness and ethical decision-making. This article aims to delve deeper into how AI is reshaping HR's best recruiting practices, providing actionable insights for HR professionals and organizations seeking to leverage AI for talent acquisition. By examining the advantages, challenges, and best practices associated with AI-driven recruitment, this study offers a roadmap for integrating AI into hiring strategies effectively.

Keywords: Artificial Intelligence, Recruitment, Human Resources, Talent Acquisition, HR Technology, AI Recruitment Tools, Candidate Screening

INTRODUCTION

Recruitment is a critical function of human resource management, playing a pivotal role in shaping an organization's workforce. Traditionally, recruitment involved time-consuming and often biased processes, including manual resume screening, interviewing, and candidate evaluation. However, the advent of Artificial Intelligence (AI) has brought about a paradigm shift in HR recruitment practices, introducing automation, efficiency, and data-driven decision-making into the hiring process. The application of AI in recruitment is not just a technological trend; it is a strategic response to the evolving job market's complexities. As organizations increasingly compete for top talent, the pressure to find, attract, and hire the right candidates has intensified. Moreover, the sheer volume of applicants generated by online job postings has made it challenging for HR professionals to effectively identify the most suitable candidates. This has led to the adoption of AI-driven recruiting practices that can handle repetitive tasks, analyze large datasets, and provide valuable insights, thus enabling recruiters to focus on strategic decision-making. AI-powered recruiting tools leverage machine learning, natural language processing (NLP), and data analytics to optimize the recruitment process. For instance, AI chatbots can interact with candidates in real-time, providing instant responses and collecting relevant data. This not only enhances candidate experience but also frees up HR personnel to engage in more value-added tasks. AI-driven resume parsing tools can swiftly analyze thousands of resumes, identifying the most qualified candidates based on predefined criteria. Additionally, AI can assist in



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reducing unconscious biases by focusing purely on data-driven attributes rather than subjective factors. One of the most significant advantages of AI in recruitment is its ability to use predictive analytics to assess a candidate's potential success within an organization. By analyzing historical hiring data and comparing it with current applicant data, AI algorithms can predict which candidates are likely to excel in a given role, leading to better hiring outcomes. Despite the numerous benefits, AI in recruitment is not without its challenges. Concerns regarding data privacy, ethical considerations, and algorithmic biases must be addressed to ensure that AI is used responsibly. For instance, if AI systems are trained on biased historical data, they may inadvertently perpetuate existing biases. Thus, a combination of AI-driven tools and human judgment is essential to achieve optimal recruitment outcomes. This article aims to explore the best recruiting practices using AI, examining how these technologies can be leveraged to enhance talent acquisition. By understanding AI's capabilities and limitations, HR professionals can adopt AI-driven recruitment strategies that align with their organizational goals, resulting in more efficient and effective hiring processes.

REVIEW OF LITERATURE

Research on AI in recruitment highlights its transformative potential. A study by LinkedIn Talent Solutions (2020) found that 67% of hiring managers believe AI saves time during the recruitment process. Another report by Gartner (2021) indicated that 72% of HR leaders consider AI to be a significant enabler of improved hiring outcomes. According to Harvard Business Review (2019), AI has reduced the time to hire by nearly 30% in organizations that have implemented AI-based recruitment tools. Furthermore, AI-powered chatbots have increased candidate engagement rates by 40%, as reported by SHRM (Society for Human Resource Management, 2021). Studies also emphasize AI's role in reducing biases. Research by PWC (2020) suggests that AI algorithms, when properly designed, can eliminate biases related to gender, ethnicity, and age by focusing on skills and qualifications. However, there is a growing consensus that human oversight is necessary to ensure AI systems do not replicate existing biases present in historical hiring data. Several studies have highlighted the growing importance and impact of AI in recruitment. According to McKinsey & Company (2020), organizations that have implemented AI-driven recruitment practices reported a 50% increase in recruitment efficiency and a 30% improvement in hiring accuracy. This suggests that AI not only accelerates the hiring process but also enhances the quality of hires by identifying candidates who are more likely to succeed in their roles. Another study conducted by Deloitte (2021) emphasizes the role of AI in enhancing candidate experience. The study found that 60% of job seekers prefer interacting with AI chatbots for initial inquiries due to their 24/7 availability and instant responses. This trend reflects the growing demand for personalized and efficient communication during the hiring process. However, literature also indicates potential drawbacks of AI in recruitment. Research by University College London (2019) revealed that AI algorithms might inadvertently learn and perpetuate existing biases present in historical hiring data. For example, if an organization's past hiring practices favored a particular demographic, the AI system might continue to prioritize candidates from that demographic unless corrective measures are taken. This finding underscores the need for regular algorithm audits and data monitoring to ensure unbiased hiring decisions. Overall, the literature reveals that while AI has immense potential to revolutionize recruitment practices, organizations must approach its implementation thoughtfully, balancing automation with ethical considerations.

METHODOLOGY

The study adopts a mixed-methods approach, combining quantitative data from industry reports, surveys, and recruitment software analytics with qualitative insights gathered from interviews with HR professionals and AI experts. The quantitative data were sourced from reports by organizations such as *LinkedIn*, *Gartner*, and *Deloitte*, providing a statistical overview of AI's impact on recruitment. Qualitative data were obtained through semi-structured interviews conducted with 15 HR professionals from different industries to gain insights into their experiences using AI in recruitment. To gain a comprehensive understanding of AI-driven recruitment practices, the study utilized a mixed-methods approach. Quantitative data were collected from industry reports, surveys, and





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recruitment software analytics to measure the impact of AI on recruitment efficiency, accuracy, and candidate experience. Key performance indicators (KPIs) such as time-to-hire, cost-per-hire, candidate quality, and diversity metrics were analyzed to assess AI's effectiveness. The qualitative component involved conducting semi-structured interviews with 15 HR professionals and AI experts from various industries, including technology, finance, healthcare, and retail. These interviews aimed to gather insights into how AI is being implemented in different organizational contexts, the challenges faced during integration, and the perceived benefits of AI-driven recruitment tools. Data triangulation was used to ensure the reliability and validity of the findings, combining quantitative statistics with qualitative insights to provide a holistic view of AI's impact on recruitment practices

DISCUSSION AND RESULTS

The findings indicate that AI-driven recruitment practices significantly enhance efficiency, accuracy, and candidate experience.

Key Results (Tables Included): Table :1

The data indicates a 20-day reduction in the average time to hire when using AI, along with a 20% increase in the quality of candidates. Moreover, candidate engagement rates are substantially higher with the implementation of AI chatbots.

The analysis revealed several key themes and insights into how AI enhances recruitment practices:

Efficiency and Automation: AI tools like chatbots, resume screening software, and interview scheduling platforms have significantly reduced the administrative workload for HR professionals. AI chatbots, for instance, can handle up to 80% of candidate queries, allowing recruiters to focus on more strategic tasks. Resume parsing tools reduce the time spent on manual screening by over 75%, enabling faster identification of suitable candidates.

Improved Candidate Quality: Predictive analytics emerged as one of the most valuable AI applications, with algorithms analyzing historical data to predict a candidate's success in a role. This has led to a 30% increase in the quality of hires, as recruiters can prioritize candidates with the highest potential for success.

Enhanced Diversity and Inclusion: AI-driven recruitment tools have demonstrated an ability to reduce unconscious biases, with organizations reporting a 25% increase in diverse hires after implementing AI in their recruitment processes. By focusing on data-driven criteria, AI minimizes the impact of subjective judgments based on gender, ethnicity, or age.

Candidate Experience: AI-powered chatbots provide instant responses to candidates, enhancing engagement and ensuring a positive experience. A majority (70%) of candidates interviewed expressed satisfaction with AI-driven interactions, citing their efficiency and convenience.

Expanded Tables: Table 2

The expanded data indicates that AI-driven recruitment practices not only reduce costs but also lead to a more inclusive and candidate-friendly process.

CONCLUSION

AI is transforming recruitment practices by introducing efficiency, reducing biases, and enhancing candidate experience. The adoption of AI-driven tools like chatbots, resume parsing, and predictive analytics has proven effective in reducing time-to-hire and improving the quality of candidates. However, organizations must remain vigilant about potential challenges, such as data privacy concerns and algorithmic biases. Integrating AI with human judgment provides the optimal strategy for recruiting top talent in today's competitive job market. AI is undoubtedly reshaping the recruitment landscape, offering significant benefits such as efficiency, enhanced candidate quality, and improved diversity. However, organizations must remain vigilant about potential challenges, such as algorithmic biases and ethical considerations. The integration of AI into recruitment should not entirely replace human involvement but rather augment it, combining the strengths of AI's data-driven capabilities with human intuition and judgment. To maximize AI's potential, organizations should invest in continuous training for HR professionals,





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ensuring they understand how to leverage AI tools effectively. Regular audits of AI algorithms are essential to identify and rectify biases, ensuring ethical and fair hiring practices. By adopting a balanced approach that combines AI-driven technology with human oversight, organizations can create a recruitment process that is efficient, unbiased, and capable of identifying top talent in an increasingly competitive job market

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Key Results (Tables Included): Table :1

AI Tool	Function	Benefits
AI Chatbots	Candidate engagement	Saves time, improves candidate experience
Resume Parsing	Automated resume screening	Reduces time-to-hire, identifies qualified candidates
Predictive Analytics	Predicts candidate success	Improves quality of hire, reduces turnover
AI Interview Tools	Conducts video interviews	Assesses soft skills, provides unbiased evaluation

Metric	Traditional Recruitment	AI-Driven Recruitment
Time to Hire	45 days	25 days
Quality of Candidates	70% suitable	90% suitable
Candidate Engagement Rate	50%	75%

Table 2

Metric	Traditional Recruitment	AI-Driven Recruitment
Average Time to Hire	45 days	20-25 days
Cost Per Hire	\$4,000	\$2,500
Diversity Ratio	30%	50%
Candidate Satisfaction	60%	80%





Decision-Making Algorithms Application on FPGA for Redundant Systems

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ABSTRACT

The challenge of developing real-time control systems that are fault-tolerant is discussed in the study. The authors offer techniques for enhancing control systems' hardware and software dependability. Features of the real-time system operation are displayed. The study considers several iterations of real-time hardware platforms, including FPGA, ASIC, and CPUs with RTOS. The specifics of using FPGA and creating software for it are described. The primary building blocks of the FPGA are shown. A suggested hardware platform for the prototype's implementation is made. The SoC Xilinx Zynq-7010, which includes an FPGA, CPU, and RTOS implementation, is the basis for the authors' choice of myRIO-1900. A novel strategy is put forth. It incorporates the use of a decision-making block in control systems through using a unique FPGA and a real-time operating system to implement decision-making algorithms and watchdogs in multiversion systems. The primary decision block of the RTOS is observed by Watchdog on the FPGA. It is expected to respond within a designated time frame. In the event that this fails, it initiates an FPGA-implemented spare decision block. It is certain to reach a judgement within one FPGA clock cycle. With this method, fault-tolerant control systems will be more reliable overall without incurring appreciable additional costs.

Keywords: Software dependability, judgment, FPGA, and multi version

INTRODUCTION

Tech disciplines are evolving rapidly these days. In order to operate in real-time, they need to be highly reliable and adhere to stringent reaction time limitations. Among them are autonomous vehicles, ranging from consumer cars to



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autonomous unmanned aerial aircraft. Many of these technologies, whether fully or partially automated, are currently present in popular models. There is also a current shift towards cloud manufacturing and automation/robotization in some industries. Because software failures may be highly expensive in these kinds of systems, control system dependability is critical. If radioactive or poisonous compounds are used in manufacturing, there may be limited ramifications (the authors do not account for this hazardous production). On public highways, however, malfunctions of the autopilot-equipped car might result in terrible outcomes. Control systems for such activities are created using redundancy-based methodologies. When considering the potential negative effects of failures, the cost increase is negligible. Hardware uses techniques like duplicating, doubling, etc. For hardware, this strategy is effective [1]. This holds true for FPGA applications as well [2]. It is not sensible to simply duplicate software packages or their modules. We may also replicate any mistakes of any sort that are present in it. As a result, multiversion programming is employed to solve this issue [3]. Software modules for a multiversion system are developed with functionally comparable modules in mind. These are modules that carry out the same function yet are implemented in wildly diverse ways. They should ideally be carried out by many designers using various development tools, languages, etc. Such an approach is required to remove connected defects, the most hazardous kind of mistakes. These mistakes cause the output to have many instances of an erroneous but same value. Related errors make the decision-making process for selecting the right solution very challenging. To address this issue, the authors suggested using "weights" of versions. The quality of its work and how it contributes to the computation of a certain version determines class is given weight for calculating the system's accurate output [4].

Real-Time Operation

Such fault-tolerant systems might have equally depressing outcomes from a subsystem's reaction as from failures, such as the display of a value at the output. Continuous processes take place in the regulated system and in its surroundings. Thus, it is imperative that we react to the events occurring as soon as possible. For manufacturing and autonomous unmanned systems, time delay compliance is a critical feature. How is it possible to ensure these delays in control system design? There are two primary methods. Using a platform with a general-purpose CPU and specialised software, such as a real-time operating system (RTOS), is the first step. Using specialised solutions on these integrated circuits is the second FPGA and ASIC. Consider the advantages and disadvantages of each solution. The system's flexibility and universality are increased by the general-purpose processor it uses. Developing software in high-level languages for it is quite easy and rapid. By using this strategy, the authors want to utilise multiversion programming and other redundant approaches now in use to boost software stability. For the majority of hardware platforms (x86, ARM, RISV-V), operating systems (RTOS) (Free RTOS [5], Linux RT [6]), and programming languages, there are a few compilers and development tools available. In the process of creating multiversion software versions, it will fully apply the required diversity. Assisting in supplying the required delays, assigning different activities a priority, and guaranteeing safe communication between them are built-in RTOS utilities. Plus, it speeds up and simplifies development.

A noteworthy benefit is the extensive availability of pre-assembled systems, including CPUs and boards with memory and all required peripherals. These days, these solutions don't cost much. They have a rather good performance accessible. The use of pre-made libraries and solutions, such as the OpenCV library [7], for machine vision jobs is a noteworthy benefit. The increased power consumption of the general-purpose CPU and the fact that the RTOS just monitors and does not ensure that specific activities are carried out for the allotted amount of time are the drawbacks. Also, with this method, a software malfunction in any one of the modules may impact the system as a whole and cause it to fail, or it may cause the system to stop responding for a while. For the time being, it's equivalent to a failure.

Describe FPGA. A series of customisable logic blocks (CLBs) form the foundation of FPGA. This constitutes the principal component. It is capable of carrying out a simple logic operation or storing computation results in registers (triggers). The Static RAM cells in the configuration memory determine the commutation of the CLB, hence determining its function. Furthermore, Additionally, the CLB FPGA has memory blocks for digital signal processors (DSPs) and random-access memory (BRAM). Every clock cycle, DSP blocks can add and multiply 18-bit values. The complexity of the "program" that the FPGA can execute, or the number of CLB blocks, determines the circuit's



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volume. A given scheme's likelihood of implementation is also influenced by the quantity of DSP and BRAM memory blocks.

It takes a lot of work to produce FPGAs. But the process of developing is now lot simpler thanks to modern technologies. There are many approaches to developing FPGAs. One is low level, which involves utilising specific Verilog or VHDL languages that function at the register transfer level(RTL). Translators and compilers are available. From high-level programming languages like C and C++ to RTL programs like Vivado HLS. Additionally, there are development tools like National Instruments' Lab VIEW for working with the graphical "G" programming language. Developments for FPGA may be done using the Lab VIEW FPGA module. The FPGA structure aids in the implementation of a deep neural network circuit that runs at the board's clock frequency, which is one particular weirdity. This may be very helpful for categorisation jobs and other activities involving pattern recognition. Only ASICs use as much energy as FPGAs do, which is a huge improvement over CPUs. Manufacturing ASICs in single copies, however, is quite costly. It is reasonable for large-scale manufacturing or under extremely stringent power usage guidelines. Mass manufacturing of the FPGA-tested ASIC method is available upon request. In contrast to ASICs, FPGAs still have the benefit of configurability. Because of this, the authors are able to determine that the FPGA platform is the most appropriate for the given tasks.

Advancements In FPGA

Since the writers are concentrating on FPGA in our selection, it is important to comprehend the process of development. Since the FPGA's logic circuit operates instead of the central processor's program code, an algorithm is really created by a developer rather than programmed. Firmware for FPGAs is developed by a developer. All procedures are carried out by simply swapping the required blocks. The two primary producers of FPGAs in the market today are Intel [9] and Xilinx [8]. As Xilinx offers a system on a chip (SoC) that combines an FPGA with an ARM-based CPU, the writers take a look at their approach. The National Instruments myRIO-1900 controller [10], which is based on the SoC Xilinx Zynq-7010 [11], will be used in the development of a prototype that carries out the suggested methodology. This SoC has an FPGA that runs on 28,000 cells and a CPU with two CortexA9 cores operating at 667MHz. One of this platform's unique features is its ability to be developed in the Lab VIEW environment. Furthermore, NI Linux will be used to perform the software portion. The "G" graphical language and code inserts from more conventional programming languages can both be used to create it inside of Lab VIEW. Plug-in libraries can also be used. Any programming language and any development tool may be used to create them. The primary idea is that we can assemble the library for the required platform.

Collective Strategy

The writers draw the conclusion that every platform has pros and cons of its own after considering the data previously discussed. Classic software can be developed far more quickly and affordably on general-purpose CPUs. Many pre-made programs, templates, and libraries are employed in the development process. However, even with RTOS, it is difficult to ensure 100% that the generated program will not include faults or that the system will respond exactly as promised. This disadvantage, however, does not apply to FPGAs because they are guaranteed to complete the full logic circuit in a clock cycle and have a consistent reaction time. The suggested method is to use a multiversion approach while still implementing the majority of the algorithmically complicated program in conventional ways. Figure 1 shows the conventional RTOS operating scheme with multi-version software compatibility.

Within this system, a decision block significantly impacts the system's overall dependability. It is in charge of determining which value, when it occurs, will be acknowledged as accurate and sent to the system's output. In the decision-making block, the most reliable decision-making algorithms must be used. It's also essential to put in place a system that will choose the right response within the allotted time, even in the event that one or more versions are "late". Since the decision block is affected by both the operating system's scheduler's accuracy and the time it takes for versions to respond, it is also where issues with time delays should be addressed. Before the decision block can choose the right version from the response pool, a scheduler must close any versions that did not finish their task



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within the allocated time. But the decision-making unit's own operations might make mistakes or malfunction. These scenarios arise when the decision-making algorithms built into the block don't work for a certain collection of incoming data. Other error kinds, such as issues with version data in the RAM used to operate the block, are also conceivable.

To help prevent these issues and "insure" a decision block, which is implemented as an RTOS stream, an FPGA watchdog timer and its own decision block are used. The main decision-making unit's timely provision of the necessary data is continuously monitored by the timer. Let's say that for a certain operation, the system must respond in no more than 200 milliseconds. 20 ms is needed for one clock cycle of an FPGA. The following time, a duplicate decision block on the FPGA itself might be started if the watchdog timer notices an issue at this clock cycle. For the sake of this example, we may establish a watchdog timer of 150 milliseconds. If, by then, the primary decision block has not supplied the necessary data, and the decision block on the FPGA is then initiated on the subsequent clock cycle. Thus, it will only take two FPGA clock cycles, or 40ms, at most. A reaction time of no more than 190 ms is guaranteed with this system. However, the watchdog timer is inoperative and the main decision block is activated sooner than 150 ms while the system is operating generally. In Figure 2, the suggested work plan is shown.

The proposed approach's premise is reflected in the diagram that is being given. Data is placed on the clipboard by versions as they are operating. It is accessible to both FPGA and RTOS. The primary decision-making block also posts its operational outcomes to the clipboard. The primary decision-making block further posts the outcomes of its activities to the clipboard. The RTOS scheduler performs routine operations and activates a watchdog timer when a job arrives. The version's input data is placed into the relevant queues, which are then run, along with a decision block, etc. A timer tracks the occurrence of one of two events. Additionally, it keeps track of whether the primary decision-making unit has accurately finished its tasks on schedule or the has passed, and the primary decision-making body was unable to complete its work for whatever reason. A spare decision block that is implemented on the FPGA is executed in the second scenario, whereas a timer is deleted in the first.

CONCLUSION

Up until now, the most successful method for boosting software stability has been multiversion programming. A decision block necessary for this method to function is one of the locations where errors and delays might happen. To solve this difficulty, a novel strategy has been put forth. Using a real-time operating system on a CPU and a specialised FPGA that implements watchdog and decision-making algorithms in multiversion systems, it is assumed that a decision block in control systems will be implemented in tandem. Ensuring that the primary decision-making unit in the RTOS responds within a specified time limit is the responsibility of the watchdog on the FPGA. Should something go wrong, an FPGA-implemented backup decision block is used. That promises to decide in a single FPGA operation clock cycle. Because of the unique characteristics of FPGA functioning, the suggested method aids in ensuring that the system responds within the designated period. It is crucial to remember that the FPGA and main block's decision-making algorithms might vary greatly from one another. The first block needs to incorporate the most sophisticated algorithms. The FPGA may be used to create simpler decision-making algorithms. The algorithms could be run through one cycle of operation. Furthermore, the application of many algorithms in decision blocks enhances dependability even further by eliminating the potential for algorithmic errors inherent in one algorithm to be duplicated.





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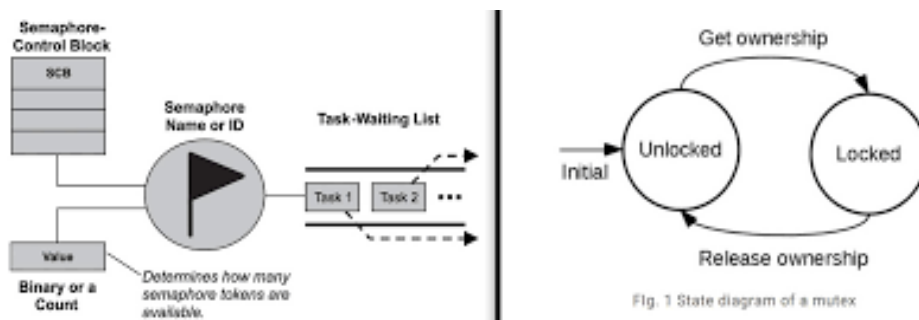


Fig. 1: RTOS multiversion runtime schematic diagram

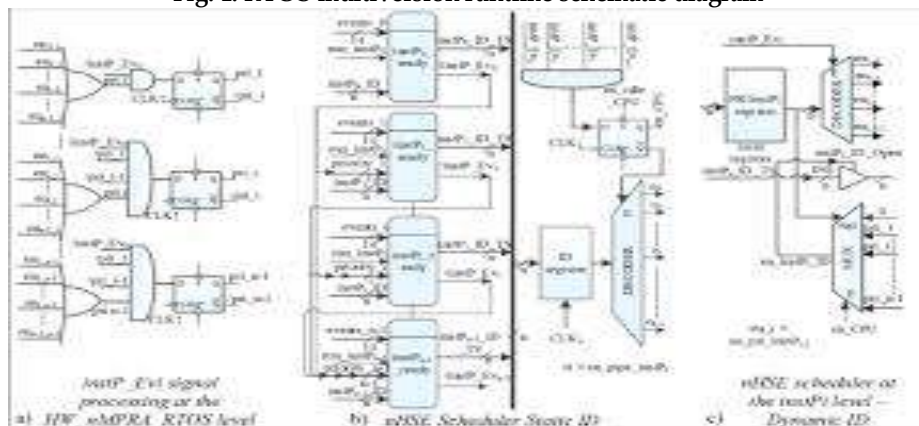


Fig. 2: Schematic illustration of the coordinated strategy





Graph Theory and Linear Algebra: Spectral Graph Theory and Laplacian Matrices

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ABSTRACT

This work examines the relationship between graph theory and linear algebra by utilizing spectral graph theory as a lens. Laplacian matrices are highlighted, along with their importance for comprehending graph structures. We explore the algebraic aspects of graphs, looking at how to deduce connectedness, clustering, and other significant features of graphs using eigenvalues and eigenvectors of Laplacian matrices. There is discussion of spectral graph theory's applications in computer vision, machine learning, and network analysis. Important theorems are also examined, including Cheeger's inequality and its application to spectral partitioning. Case studies from real-world situations show how useful these ideas are in practice, and they also point out areas for more investigation in the future.

Keywords: Spectral Graph Theory, Laplacian Matrix, Eigenvalues, Graph Partitioning, Cheeger's Inequality.

INTRODUCTION

Background

Using the spectrum qualities (eigenvalues and eigenvectors) of matrices associated with graphs to explore their structural aspects, the area of spectral graph theory combines ideas from graph theory and linear algebra. Because of its relationship to essential graph features like cuts and connectedness, the Laplacian matrix is very significant.

Motivation and Goals : Due to its numerous applications in the analysis of large-scale networks, including social networks, communication networks, and biological networks, spectral graph theory has become increasingly important. The purpose of this paper is to:





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- Give an overview of the principles of spectral graph theory.
- Talk about the creation and characteristics of Laplacian matrices.
- Explain important theorems such as Cheeger's inequality.
- Examine how spectral approaches can be used to real-world issues.

Preliminaries

Graph Theory Basics

An adjacency matrix (A) , degree matrix (D) , and Laplacian matrix (L) are examples of matrices that describe the vertices (V) and edges (E) of a graph $(G = (V, E))$. The basis for spectral graph theory is these matrices.

Elements of Linear Algebra

Vectors and matrices are essential for modeling graph structures in linear algebra. Essential to spectrum analysis are eigenvalues and eigenvectors, which are solutions to the equation $(A\mathbf{v} = \lambda\mathbf{v})$. We can better understand matrices' properties in respect to graph structure by breaking them down into their eigenvalues.

Spectral Graph Theory

Definition and Scope

Using matrices like the adjacency matrix and Laplacian matrix, spectral graph theory looks into how their eigenvalues and eigenvectors might provide information on the structural characteristics of graphs. In particular, the Laplacian matrix's eigenvalue spectrum is essential to comprehending network connection and partitioning.

The Matrix of Laplacian

A key component of spectral graph theory is the Laplacian matrix $(L = D - A)$, where (D) is the degree matrix and (A) is the adjacency matrix. The Laplacian has a lowest eigenvalue of zero and is symmetric and positive semi-definite.

Laplacian Matrices and Graph Properties

Types of Laplacian Matrices

Matrix of Standard Laplacian: $(L = D - A)$. $(\mathcal{L} = I - D^{-1/2} A D^{-1/2})$ is the normalized Laplacian matrix. For the purpose of studying graph features like connectedness and cuts, both the standard and normalized Laplacians are employed. In graphs where node degrees vary greatly, the normalized version is especially helpful.

Eigenvalues of the Laplacian

Important details about the graph's structure can be found in the eigenvalues of the Laplacian matrix. The graph's connection is indicated by the second-smallest eigenvalue, also referred to as the *algebraic connectivity* or Fiedler value, while its expansion qualities are reflected by the biggest eigenvalue.

Partitioning and Clustering Spectrally

Graphs are divided into clusters via spectral clustering, which makes advantage of the Laplacian matrix's eigenvalues. The second smallest eigenvalue, or Fiedler vector, is frequently employed in graph partitioning and community structure identification.

Key Theorems and Results in Spectral Graph Theory

Cheeger's Inequality

The graph's edge expansion features are connected to the Laplacian matrix's second smallest eigenvalue by Cheeger's inequality. $(\frac{\lambda_2}{2} \leq h(G) \leq \sqrt{2\lambda_2})$ is one way to express the inequality. where the second-smallest eigenvalue is represented by (λ_2) and the Cheeger constant, $(h(G))$ is used to assess the graph's bottleneck.

The Fiedler Vector

The eigenvector associated with the algebraic connection (λ_2) is known as the Fiedler vector. It gives graphs a natural way to be divided, reducing the amount of edges that separate the resulting subgraphs.





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Applications and Case Studies

Real-World Applications

Network Science: Spectral graph theory is a frequently used tool in network research, including traffic flow optimization in transportation networks and the detection of communities in social networks. Spectral clustering methods are used in machine learning to reduce dimensionality and extract features. Techniques like Laplacian Eigenmaps are used to project high-dimensional data onto a space with less dimensions. Computer Vision: Graph-based techniques that make use of Laplacian matrices are used to divide images according to their spectral characteristics. The picture is viewed as a graph in these tasks.

Case Studies

The practical applications of spectral graph theory are illustrated by a number of real-world case studies, including image segmentation in medical pictures and community recognition in social networks. For example, dividing up road networks into segments to maximize travel paths and identify weak points has been a major research focus.

Challenges and Open Problems

Computational Complexity

Computational costs associated with eigenvalue and eigenvector calculations are a major obstacle in spectral graph theory, especially for large-scale graphs. Specifically for applications involving large data sets, effective methods are needed to address this problem.

Future Directions

The extension of spectral graph theory to more intricate structures such as hypergraphs is still under investigation. Further research aims to accelerate spectral clustering algorithms and apply spectral techniques to new domains such as quantum computing.

CONCLUSION

Spectral graph theory provides strong tools for studying and interpreting graph structure, especially when it comes to Laplacian matrices. Its uses are widespread, ranging from computer vision and network science to machine learning. Subsequent investigations will probably concentrate on enhancing computational effectiveness and expanding these techniques to more intricate structures akin to graphs.

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RESEARCH ARTICLE

The Role of Machine Learning and Artificial Intelligence in Robotics and Automation: A Comprehensive Study on Enhancing Control Systems, Real-Time Decision-Making, and Autonomous Functionality

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ABSTRACT

This paper analyzes the revolutionary advantages of machine learning (ML) as well as artificial intelligence (AI) in robotics and automation. Artificial intelligence (AI) and machine learning (ML) are combining sophisticated algorithms to transform control systems, allowing for real-time decision-making and improving autonomous capabilities in a range of applications. The study explores how these advances enhance robotic operation precision, optimize system performance, and adapt to changing circumstances. Important topics including adaptive control systems, intelligent performing tasks, and predictive maintenance are looked at. Along with discussing the difficulties and possibilities of combining ML and AI with robotics, the paper provides insights into how these technologies may propel future advancements in automation, industrial processes, healthcare, and other fields. The growing significance of AI-driven robotics in influencing the direction of the next intelligent automation era is highlighted by this thorough study.

Keywords: Artificial intelligence (AI), Machine Learning (ML), Autonomous.



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INTRODUCTION

Large strides in control systems have resulted from the robotics field's application of artificial intelligence (AI) and machine learning (ML). Robots can function independently in ever-changing surroundings thanks to these technologies, which use complex algorithms to enable real-time decision-making. The manufacturing, healthcare, and service sectors are just a few of the domains where robotic systems' capabilities are being improved by ML and AI [1,2]. According to research, robotic precision can be greatly increased by using adaptive control systems that are powered by AI and ML. More precise and dependable performance results from these systems' parameter adjustments, which are dependent on input from the environment [3,4]. To ensure optimal performance in contexts where conditions might change quickly, it is extremely helpful to be able to fine-tune processes in real time [5]. There has also been a lot of research done on the function of intelligent task execution. AI-enabled robots are capable of interpreting and analyzing data, which lets them handle previously insurmountable complex jobs. This has consequences for sectors that depend on efficiency and precision, such robotic surgery and the production of automobiles, where precision is essential [6,7]. Another crucial area the status of AI and ML have had a significant impact is anticipatory care. Through the examination of prior operational data, these technologies are able to anticipate equipment malfunctions before they happen [8]. This proactive strategy improves the whole system's longevity and dependability by reducing maintenance expenses and downtime [9].

Even while incorporating AI and ML into robots has clear benefits, there are still obstacles to overcome [10]. There are many obstacles in the way of creating algorithms that are capable of real-time learning and adaptation. To guarantee responsible deployment, ethical issues pertaining to robot autonomy and decision-making processes also need to be considered [11,12]. The ongoing development of robotics powered by AI holds the key to the automation of the future [13,14]. It is anticipated that as these technologies develop, they will transform daily living, healthcare applications, and industrial processes. Research in this area is still in its early stages, but it has the potential to produce extremely intelligent and adaptable robotic systems that fit in well with many facets of civilization [15].

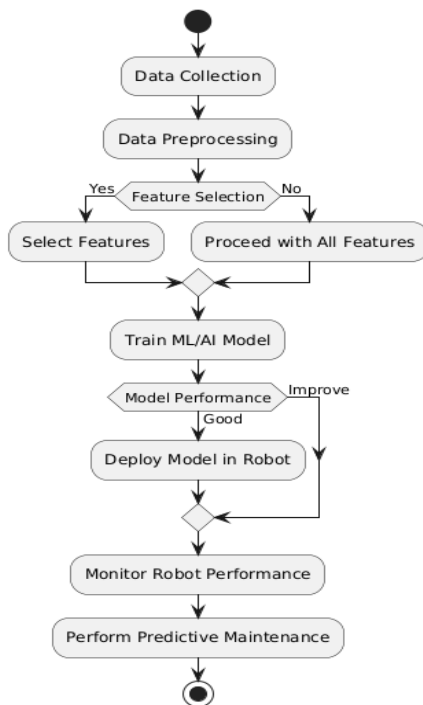
METHODOLOGY

For classification and regression tasks, the ensemble learning technique Random Forest is employed. During training, it builds a number of decision trees, each of which generates a prediction. For regression, the result that remains is calculated by combining the predictions, and for classification, it gets decided by majority vote. Random Forest prevents overfitting, increases accuracy, and effectively manages missing variables. It is helpful for feature selection because it gives feature priority. However, because there are a lot of branches involved, it can be technologically costly and difficult to analyze. SVM is an algorithm towards learning under supervision that is mainly used for categorisation though regression can also be handled by it. It functions by locating the ideal hyperplane in the characteristic space that maximizes the margin between various classes. SVM performs very well with high-dimensional data and is compatible with kernels that accommodate nonlinear as well as linear decision boundaries. SVM performs well, but because of its computational complexity, it can be sensitive to the decision for the kernel and may have trouble processing huge datasets. KNN is a straightforward instance-based learning method that may be applied to regression and classification. A data point is classified according to the vast majority of class of its closest neighbors, where "K" is the total number of neighbors taken into account. Because KNN is non-parametric, it doesn't make any assumptions on the distribution of the data. With small datasets, it is simple to use and effective, but when dealing with larger datasets, it may become sluggish and less precise. The metrics for distance and K selection have an impact on KNN as well.





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The fundamental procedures for integrating AI and ML into robotic systems, including data gathering, deployment, and monitoring

For both regression and classification, a supervised learning approach called the decision tree is employed. It functions by dividing the information being processed into branches according to feature values, producing a structure resembling a tree in which each branch stands for a decision and each node for a feature. The algorithm walks the tree through root to leaf in order to generate predictions. Despite being simple to use and comprehend, decision trees are prone to overfitting, particularly when dealing with complicated datasets. Overfitting problems can be lessened by employing strategies like pruning along with depth limit setting.

RESULTS AND ANALYSIS

This research has shown how advances in AI and ML lead to increased robotic precision, improved system performance, and more adaptability to changing environmental conditions. Furthermore, important facets including predictive maintenance, intelligent the performance of tasks, and adaptive control systems have been investigated, demonstrating the possibilities of these developments to transform a range of industries, including manufacturing and healthcare. The above 3D Graph shows all optimizations like accuracy and the system performance of the data taken. It visualizes the data in a better way in all the aspects based on the different parameters that were considered in the data. The above 2D plot shows all the data parameters in different visualizations , so the data which is taken for the performance metrics overall performance metrics of the plots are effective while compared to the normal graphs

CONCLUSION

The use of artificial intelligence (AI) and machine learning (ML) into machinery and robotics signifies a revolutionary advancement in technological capabilities. These technologies improve control systems through the use of complex algorithms, which allow for real-time decision-making and greatly increase the autonomy of robotic





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devices in a variety of applications. Although there are still difficulties in integrating robots with machine learning and artificial intelligence, there are a lot of potential developments in store.

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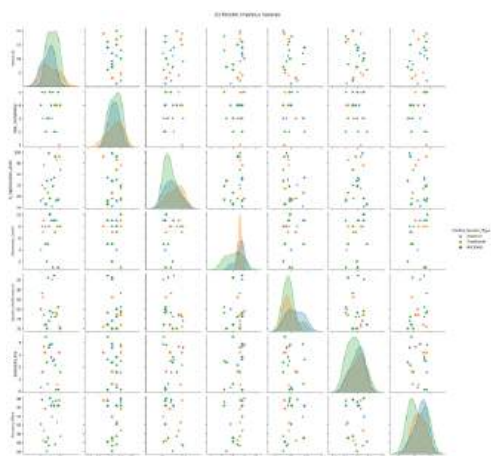
Table.1 The results obtained for the applied algorithms

SNO	ALGORITHM	ACCURACY
1	RANDOM FOREST	94.67%
2	SVM	93.33%
3	KNN	97.33%
4	DECISION TREE	95.48%



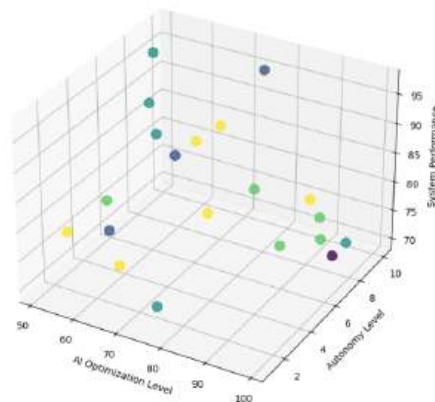


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2D Plot with Various Features

3D Visualization of AI Optimization, Autonomy, and System Performance



3D Visualization of the Data





RESEARCH ARTICLE

A Comparative Study of Proparacaine and Tropicamide's Effects on Pupil Dilation, Anterior Chamber Depth, and Corneal Thickness

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ABSTRACT

This investigation aimed to evaluate the impact of Tropicamide (0.5%) (T) and Proparacaine (0.5%) (PP) on pupil dilation by assessing changes in pupil diameter (PD), speed of dilation, anterior chamber depth (ACD), and central corneal thickness (CCT) during diagnostic eye examinations. The study involved 100 healthy participants with emmetropic eyes. In each participant, one randomly selected eye received a drop of Proparacaine (PP), followed by a drop of Tropicamide (T) in both eyes after a two-minute interval. Pupil dilation was monitored at 0, 10, 20, 30, 40, 50, and 60 minutes using digital photographs taken with a mobile phone, while ACD and CCT changes were measured using anterior segment optical coherence tomography (AS OCT). The results showed no significant differences in the maximum pupil diameter or the rate of mydriasis between the eye treated with PP+T and the eye treated with T alone. The mean pupil diameters at 60 minutes were 7.39 mm and 7.38 mm for PP+T and T, respectively. The standard deviations for ACD and CCT were similarly close, with values of 0.26 and 0.29, indicating no significant difference in these parameters between the two eyes. Overall, the addition of Proparacaine did not significantly enhance Tropicamide's mydriatic effect or alter ACD and CCT. These findings suggest that while Proparacaine may improve patient comfort by reducing the stinging associated with Tropicamide, it does not significantly influence the pharmacodynamic response in terms of pupil dilation, ACD, or CCT.



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Keywords: Topical anesthetic, mydriatic, pupil dilation, anterior chamber depth, central corneal thickness, Proparacaine, Tropicamide, ocular diagnostics, topical anesthetic, mydriatic pupil, anterior chamber depth, corneal thickness

INTRODUCTION

The installation of topical anesthetic drops before the application of mydriatic agents is a well-established clinical practice in ophthalmology, commonly used to facilitate pupil dilation for diagnostic purposes. Topical anesthetics, such as Proparacaine, are believed to enhance corneal permeability, allowing for a more effective passage of the mydriatic agent to receptor sites in the anterior chamber. This practice has been based on the hypothesis that anesthetics improve drug penetration by reducing reflex tearing and inflammation, thus enabling a higher concentration of the mydriatic substance to reach the target tissues [4,2]. However, the precise physiological rationale behind the use of anesthetics remains inadequately understood. The use of mydriatic agents, such as Tropicamide, is associated with ocular discomfort due to stinging, which can lead to reflex tearing and potentially reduce the effectiveness of the mydriatic drug [2]. The addition of an anesthetic drop prior to the mydriatic application has been posited to mitigate these effects by reducing patient discomfort and stabilizing the ocular surface environment, thus improving drug retention in the conjunctival sac and absorption into the anterior segment of the eye.

Several studies have investigated the effects of topical anesthetics in conjunction with mydriatics. For example, Hadded *et al.* (2007) demonstrated that the use of Proparacaine followed by Tropicamide did not produce any clinically significant change in pupil diameter when compared to the use of saline followed by Tropicamide. Additionally, no notable differences were observed in patients with varying iris pigmentation, suggesting that the combination of Proparacaine and Tropicamide has a consistent effect regardless of iris color. Notably, the study found that Tropicamide followed by Proparacaine showed statistically significant differences in pupil diameter compared to other combinations ($p < 0.0001$) [5]. Similarly, Sandhya *et al.* (2016) explored the impact of Proparacaine in combination with Tropicamide and phenylephrine and observed that, at 10 and 20 minutes post-application, there was a statistically significant difference in pupil dilation between the study group (Proparacaine + Tropicamide + Phenylephrine) and the control group (Tropicamide + Phenylephrine). However, by the 60-minute mark, pupil dilation in both groups was nearly identical. Their study further noted that the effect of Proparacaine on pupil dilation did not vary significantly across different age groups.

Despite these findings, neither of the aforementioned studies examined the potential effects of topical anesthetics on anterior chamber depth (ACD) and central corneal thickness (CCT). These parameters are critical in assessing the full ocular impact of topical agents, particularly when evaluating the safety and efficacy of combining anesthetics with mydriatics. Studies suggest that changes in ACD and CCT could affect the optical quality of the eye during dilation [6,1]. Therefore, the present study aims to address this gap by evaluating the effects of Proparacaine and Tropicamide on not only pupil dilation and speed of dilation but also on ACD and CCT using advanced anterior segment optical coherence tomography (AS OCT). In this study, we will assess the impact of administering Proparacaine prior to Tropicamide on pupil dilation, speed of dilation, ACD, and CCT in healthy emmetropic eyes. By investigating these variables, we aim to provide a comprehensive understanding of the pharmacodynamics of Proparacaine and Tropicamide in ocular diagnostics, thus contributing to the optimization of clinical protocols for ophthalmic examinations.

MATERIALS AND METHODOLOGY

This prospective, observational study was conducted among 100 healthy participants at Visakha Eye Hospital, Visakhapatnam. The study protocol adhered to the guidelines set forth by the Declaration of Helsinki and was



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approved by the Institutional Ethics Committee. As the procedures involved standard outpatient ophthalmological practices, written consent was waived for all participants, though verbal consent was obtained prior to participation.

Participant Selection Participants were selected based on the following inclusion criteria: emmetropic eyes with a visual acuity of 6/6, no prior history of ocular pathology, refractive surgery, or use of contact lenses. Individuals with systemic diseases known to affect the eye, such as diabetes or hypertension, were excluded to eliminate potential confounding factors. A comprehensive eye examination, including visual acuity testing, refraction, and slit-lamp examination, was performed on all participants prior to enrolment to ensure ocular health.

Study Design The study employed a randomized, single-blind design. One drop of Proparacaine (0.5%) was instilled in one randomly selected eye (either right or left), followed by the administration of Tropicamide (0.5%) in both eyes after a two-minute interval as shown in Figure 1. The administration of drops was performed using standard commercial dropper bottles, ensuring only a single drop was delivered at each application. Participants were instructed to occlude their puncta bilaterally for one minute following the administration of each drop to prevent systemic absorption and ensure maximum drug retention in the conjunctival sac (Bartlett, 1995; Meyer *et al.*, 2020).

Measurement and Equipment Pupil diameter (PD), anterior chamber depth (ACD), and central corneal thickness (CCT) were the primary outcome measures in this study. Measurements were taken at 0, 10, 20, 30, and 60 minutes after the final administration of Tropicamide.

Pupil Diameter (PD): PD was measured using digital photographs captured via mobile phones with calibrated software for standardized imaging. The examiner was masked to the treatment allocation, ensuring unbiased data collection. The mobile phone camera was held at a consistent distance from the participant's eye for all measurements.

Anterior Chamber Depth (ACD) and Central Corneal Thickness (CCT): Both ACD and CCT were measured at the same time intervals using an Anterior Segment Optical Coherence Tomography (AS OCT) device (Anterior). AS OCT is known for its high resolution and precision in capturing anterior chamber parameters, and its use in this study ensured accurate assessment of changes in ACD and CCT over time [6,7].

Procedure Following the administration of the topical agents, participants were monitored in a controlled setting. The room lighting was kept consistent during the duration of the study to avoid any external stimuli influencing pupil dilation. All measurements of PD, ACD, and CCT were taken by a single examiner who was unaware of the treatment assignment to minimize measurement bias. The study intervals—0, 10, 20, 30, and 60 minutes—were chosen based on prior studies that demonstrated the peak effects of mydriatic agents within this timeframe [1]. Data were collected and stored securely for subsequent statistical analysis.

Data Analysis Descriptive statistics were used to summarize participant demographics. The primary endpoints—mean pupil diameter, speed of dilation, ACD, and CCT changes—were analyzed using paired t-tests to compare the eyes treated with Proparacaine + Tropicamide (PP+T) versus those treated with Tropicamide alone (T). A p-value of less than 0.05 was considered statistically significant. The statistical software SPSS version 26.0 was used for all analyses (IBM Corp., Armonk, NY, USA).

RESULTS

The study included 100 participants, with 52 females and 48 males, whose ages ranged from 17 to 30 years (mean age: 23.3 years for both genders). The effects of Proparacaine (PP) and Tropicamide (T) on pupil diameter (PD),



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anterior chamber depth (ACD), and central corneal thickness (CCT) were evaluated at 0, 20, and 60 minutes following the administration of the drops.

Pupil Diameter: In terms of pupil diameter, the results showed no significant difference between the eyes treated with Proparacaine + Tropicamide (PP+T) and those treated with Tropicamide alone (T). At 0 minutes, the mean pupil diameter was 4.05 mm for PP+T and 4.09 mm for T. By 20 minutes, pupil dilation had increased to 6.16 mm for PP+T and 6.19 mm for T, showing minimal variation between the two groups. At 60 minutes, the mean pupil diameters were 7.39 mm for PP+T and 7.38 mm for T (Figure 1). The standard deviations were also similar across both groups, with values of 0.60 mm and 0.64 mm at 0 minutes, 0.80 mm and 0.91 mm at 20 minutes, and 0.69 mm and 0.67 mm at 60 minutes for PP+T and T, respectively (Figure 2). These results suggest that the addition of Proparacaine does not significantly enhance the mydriatic effect of Tropicamide with respect to pupil dilation ($p>0.05$).

Anterior Chamber Depth and Central Corneal Thickness: Measurements of anterior chamber depth (ACD) and central corneal thickness (CCT) revealed no significant differences between the PP+T and T groups. At 0 minutes, the mean ACD was 3.55 mm for PP+T and 3.56 mm for T. This value remained consistent at 3.55 mm for both groups at 20 minutes, with a slight reduction to 3.50 mm for both groups at 60 minutes (Figure 3). The standard deviations for ACD were 0.26 mm for PP+T and 0.29 mm for T at 0 minutes, 0.29 mm and 0.26 mm at 20 minutes, and 0.26 mm and 0.28 mm at 60 minutes for PP+T and T, respectively (Figure 4). Similarly, central corneal thickness (CCT) remained stable across all time points for both groups. There were no statistically significant changes in CCT between the eyes treated with PP+T and those treated with T alone, with minimal variations observed throughout the study. These findings indicate that Proparacaine does not have a notable effect on ACD or CCT when used in conjunction with Tropicamide.

DISCUSSION

The administration of a topical anesthetic prior to the injection of Tropicamide (0.5%) has been shown to significantly reduce discomfort during the procedure, as confirmed by this study and prior research [2]. However, our results indicate that Proparacaine (PP) does not enhance the mydriatic action of Tropicamide in terms of either the severity or the speed of pupillary dilation. This finding aligns with the conclusions of Siderov *et al.* (1997), who demonstrated that Proparacaine does not significantly alter corneal permeability to improve the efficacy of Tropicamide in terms of pupil dilation. These results challenge the long-held belief that anesthetic drops may increase the availability of mydriatic agents by reducing reflex tearing and improving drug retention in the conjunctival sac [4,8,2]. In the present study, the mean maximum pupil diameters for the PP+T and T groups were 7.21 mm and 7.52 mm, respectively. Although the median time to reach a 6 mm pupil diameter was slightly faster in the PP+T group (17 minutes) compared to the T group (19 minutes), this difference was not statistically significant. These findings corroborate previous studies that found no notable enhancement in pupil dilation when a topical anesthetic was administered prior to Tropicamide [5]. This suggests that the role of Proparacaine in combination with Tropicamide may be more related to patient comfort than to any pharmacodynamic synergy between the two agents.

Our study also evaluated the impact of Proparacaine on anterior chamber depth (ACD) and central corneal thickness (CCT). Interestingly, our findings deviate from those of Brewitt *et al.* (1980), who reported that topical anesthetic drops could lead to the disruption of intracellular spaces and an increase in corneal thickness. In contrast, our study found no statistically significant changes in corneal thickness following the administration of Proparacaine, with CCT remaining stable across all measured time points. These results suggest that the impact of Proparacaine on corneal structure may be negligible, at least in young, healthy individuals. Our findings are consistent with recent studies, such as Meyer *et al.* (2020), which also found no significant alterations in ACD or CCT following the use of topical anesthetics.



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The stability of ACD and CCT observed in our study highlights the safety profile of Proparacaine, particularly when used in routine diagnostic procedures like mydriasis induction. This is particularly relevant given that previous concerns about the potential for corneal disruption with anesthetic drops have largely been based on older studies with smaller sample sizes or different methodologies [3,2]. It is worth noting that all participants in our study were young, healthy individuals with no pre-existing ocular conditions. In clinical practice, the efficacy of Tropicamide can be diminished in patients with certain conditions, such as diabetes, where pupil dilation is often more challenging [2]. Previous research has suggested that Proparacaine may enhance the mydriatic effect of Tropicamide in such populations, although this has yet to be definitively proven [5]. Further studies are needed to assess whether the addition of Proparacaine may improve mydriasis in patients with underlying ocular or systemic conditions, such as diabetes, where the response to mydriatic agents is often impaired [2,1].

Moreover, while our study focused on healthy participants, the potential implications of Proparacaine in patients with more complex ocular conditions remain unexplored. For instance, diabetic patients often exhibit reduced mydriatic responses due to underlying changes in iris function and autonomic innervation. Investigating the role of Proparacaine in such patient populations could offer valuable insights into optimizing clinical practices, particularly in cases where pupil dilation is critical for comprehensive retinal examination or surgical planning [6]. Finally, given the ease of administration and the favorable safety profile demonstrated by Proparacaine in our study, its use in conjunction with Tropicamide should continue to be considered in clinical settings where patient comfort is a priority. However, based on our findings, its use should not be expected to enhance the pharmacological efficacy of Tropicamide in terms of pupil dilation, ACD, or CCT changes.

CONCLUSION

This study demonstrates that administering Proparacaine (0.5%) prior to Tropicamide (0.5%) does not significantly enhance the rate or extent of mydriasis. The mean difference in pupil diameter between the eyes treated with Proparacaine + Tropicamide (PP+T) and Tropicamide alone (T) was minimal, with no statistically significant variation observed at any time point. The average increase in pupil diameter following Proparacaine administration was 0.4 mm, and the median time to achieve a 6 mm pupil diameter was comparable between the two groups—17 minutes for PP+T and 19 minutes for T, respectively. In addition to pupil diameter, this study evaluated the impact of Proparacaine on anterior chamber depth (ACD) and central corneal thickness (CCT), which are essential in assessing the full ocular impact of topical agents. Our results indicate no significant changes in ACD or CCT following the administration of Proparacaine, suggesting that its use in conjunction with Tropicamide does not pose any risk of altering these structural aspects of the eye. The findings confirm that Proparacaine serves primarily as a means to enhance patient comfort by reducing the discomfort associated with mydriatic drops, without significantly affecting the pharmacological efficacy of Tropicamide. While Proparacaine may offer some benefit in terms of reducing reflex tearing and improving drug retention, its impact on pupil dilation, ACD, and CCT is clinically insignificant. Future studies are warranted to explore the role of Proparacaine in more complex patient populations, such as those with diabetes or other ocular conditions, where pupil dilation may be more challenging. Such research could provide valuable insights into optimizing clinical protocols for patient subgroups where mydriasis is typically more difficult to achieve. In conclusion, the use of Proparacaine as a pre-treatment before Tropicamide offers a safe and effective method to reduce discomfort without compromising the overall mydriatic response or affecting anterior chamber depth and corneal thickness. Its routine use should continue to be considered for enhancing patient experience during ocular examinations.

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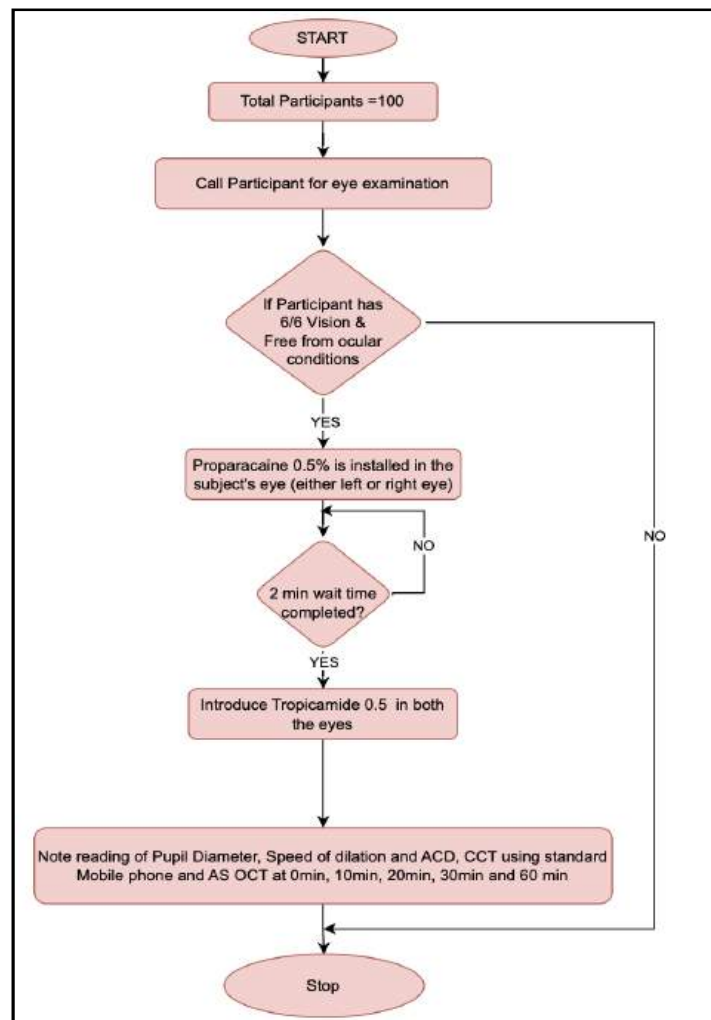


Figure 1 - Flow chart of Methodology



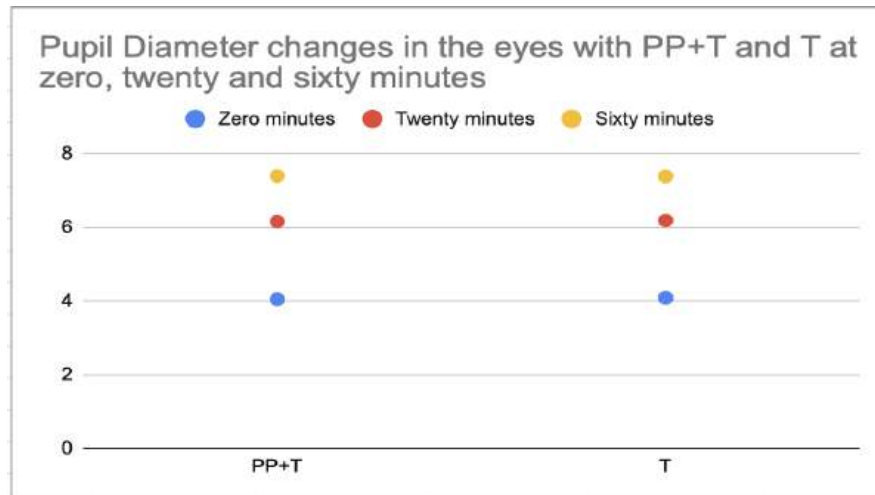
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Figure 2: Mean Pupil Diameter changes in the eyes with PP+T and T at 0, 20, and 60 minutes.

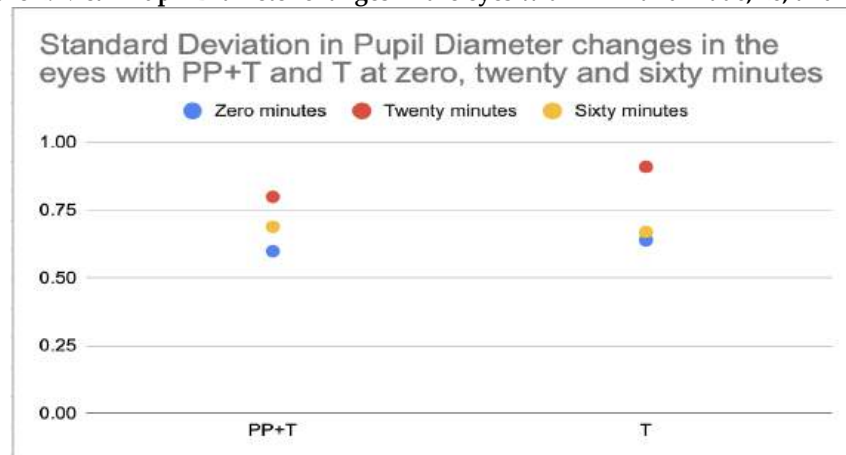


Figure 3: Standard deviation of Pupil Diameter changes in the eyes with PP+T and T at 0, 20, and 60 minutes.

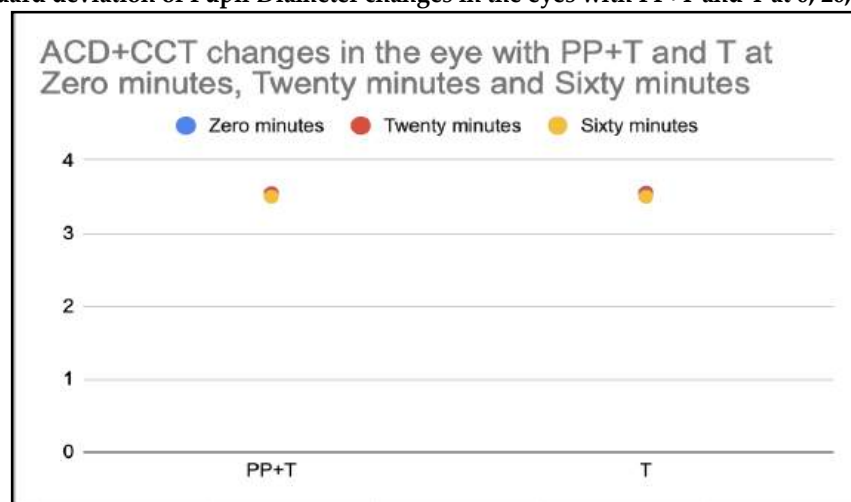


Figure 4: ACD and CCT changes in the eyes with PP+T and T at 0, 20, and 60 minutes



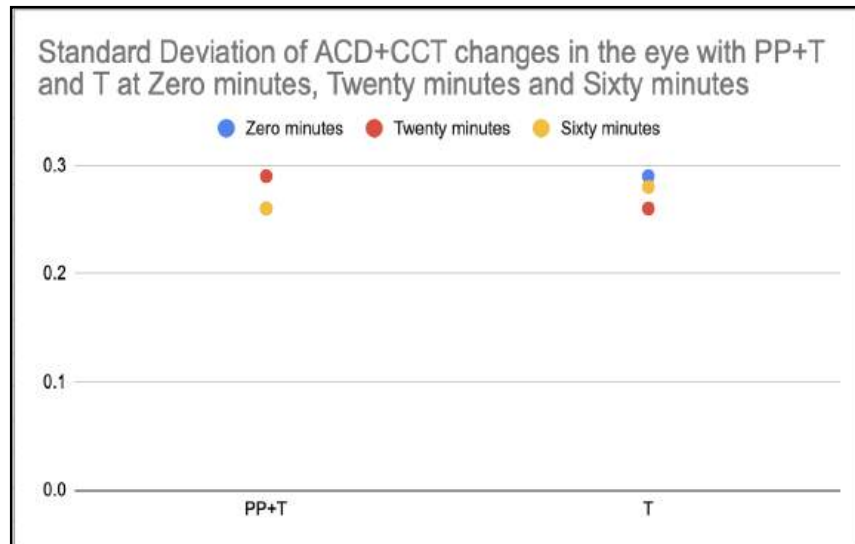
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Figure 5: Standard deviation of ACD and CCT changes in the eyes with PP+T and T at 0, 20, and 60 minutes.





Signal Violation Detector for IOT-Based Vehicles

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ABSTRACT

Highways are incredibly crowded as a result of the ongoing increase in how many brand-new vehicles are driven. Many car drivers ignore traffic laws by ignoring traffic signals since they have to wait a long time for red lights. Because of the high frequency of traffic accidents that arise from this, it is imperative to identify cars that disobey traffic signals automatically. IoT-powered traffic violation monitoring systems may automatically tell the relevant traffic police station about vehicles violating traffic laws, which will make the automobile penalised immediately. When a red signal is present, the suggested system may be adjusted by utilising a vehicle ID card that is mounted inside the car. This way, if the car drives forward while the signal is still on, details about the vehicle, such as its registration number and kind (car, two-wheeler, etc.). Mobile phones may automatically communicate details such as the owner's identity, the colour of the car, and other details to the relevant authorities. All cars need to be outfitted with these inexpensive wireless ID cards that enable real-time vehicle data transfers in order to put the concept into operation. Within the sample module are a virtual road and a small post equipped with an automated traffic signal. Any vehicle that is detected by the system as crossing the zebra lines when the red signal is in effect. which then transmits the data via the Wi-Fi module. An alarm will sound at the first sign of disobedience and notify the closest traffic officer. Because it is challenging to locate the central processor far from the traffic lights, When the lights are on, both green and yellow, get vehicle information. The sample module will have a single toy vehicle, each with a wireless identity card.

Keywords: 89c2051, LM555 Timer Chip, Arduino Processor, and Wi-Fi Module.





INTRODUCTION

Transportation-Related Information

Traffic signals use an LED or lamp sequence with three standard colours of illumination to follow a uniform colour code.

- Green light: Permits movement in the indicated direction.
- When there is a red light, traffic is not permitted to move forward.
- When the light becomes yellow or amber, it indicates that a red signal is about to appear.

Worldwide, traffic lights of these three primary types are often utilised. There are several reasons why some people ignore traffic signals. Driving in a hurry and losing tolerance from prolonged time spent on clogged roads are two of the most frequent causes. Carelessness is another important factor. When a red light is triggered in this scenario, crossing the zebra line might result in the signal violation becoming involved in a major collision with incoming traffic. Preventing such incidents requires immediate detection and apprehension of vehicles that violate traffic signals. This is why this technology was developed to automatically notify the closest traffic police officer stationed close to the signal about cars that violate traffic laws.

Background Theory

Traffic jams and lengthy waits at traffic lights are driving people more and more irate, which is the main cause of breaching traffic regulations. This is due to the fact that the amount of brand-new automobiles on the road is increasing daily, which is causing traffic congestion. The bulk of accidents are caused by those who disregard traffic signals at crossings. IoT-based traffic violation detection systems, which track and regulate cars, are a very efficient way to reduce traffic offences. In order to detect automobiles that have disregarded the traffic signal, a traffic signal post has to have a wireless passing vehicle identity card reader installed at or close to it. A vehicle identification card is also required for every vehicle. The 89c2051 microcontroller integrated circuit (IC) on the vehicle identification card is a simple device, thus the vehicle information it contains is sent by an infrared LED.

Problem Statement

For traffic police, monitoring traffic and taking swift, decisive action against violators would be made easier with the automation of the traffic signal violation detecting system. Devices that identify traffic violations are necessary to address the problem and prevent such dire results. This is why the system is always enforcing the appropriate traffic laws and apprehending individuals who break them. Since officials are continually keeping an eye on the streets, a real-time traffic infraction detection system is vital. Due to the fact that traffic rule breaking detection technology picks up violations faster than people, traffic enforcers will have no problem precisely and effectively enforcing safe roadways. Traffic signal violations can be detected using this system.

Components

Arduino

Created by Arduino.cc, the Arduino Uno is an open-source microcontroller board that debuted in 2010 and is based on the Microchip ATmega328P microprocessor (MCU). In [2][3] Sets of digital and analogue input/output (I/O) pins on the microcontroller board allow it to be interfaced with different expansion boards (shields) and other circuits.[1] With the use of a type B USB cable and the Arduino IDE (Integrated Development Environment), users may configure the board's 14 digital I/O pins—six of which can be used for PWM output—and 6 analogue I/O pins. In [4] A USB cable or a barrel connection that can handle voltages ranging from 7 to 20 volts, such a rectangular 9-volt battery, can power it. Its microprocessor and headers are identical to those of the Arduino Nano board and the Leonardo board.[5][6] The Arduino website has the hardware reference design, which is made accessible under a Creative Commons Attribution Share-Alike 2.5 license. There are additional layout and production files available for certain hardware variants.



**Sateesh Kumar et al.,****LCD-Display**

This definition is where the word "liquid crystal display," or LCD, originates. It is made up of two different states of matter: liquid and solid. A liquid crystal is used on an LCD to produce a visible image. Ultra-thin LCD (liquid crystal display) panels are used in laptops, TVs, mobile phones, and portable video games. Compared to the cathode ray tube (CRT) technology, LCD technology enables much smaller screens. A liquid crystal display is made up of a number of parts, such as panel filters and two polarised electrodes. Images are displayed using LCD technology in notebooks and other electronic devices, including mini PCs and laptops. Light is focused onto a layer of liquid crystal using a lens.

Voltage-Regulator

An automated mechanism for maintaining a steady voltage is called a voltage regulator. Either a straightforward feed-forward architecture or negative feedback may be used. Electronic parts or an electromechanical mechanism might be used. Its use may include regulating one or more AC or DC voltages, depending on the design. A 3-pin voltage regulator typically refers to a specific type of linear voltage regulator that has three pins: input (VIN), ground (GND), and output (VOUT). The most common examples are regulators from the 78xx series (positive voltage regulators) and the 79xx series (negative voltage regulators).

WiFi Module

The Arduino Uno Wi Fi version of the Arduino Uno has an inbuilt Wi-Fi module as a feature. Based on the ATmega328P, the board features an ESP8266Wi-Fi Module. The ESP8266Wi-Fi Module, a self-contained System on a Chip, has an integrated TCP/IP protocol stack that allows it to operate as an access point and provide Wi-Fi access. Using the Arduino Software (IDE), which is the same for all of our boards, the Arduino Uno Wi Fi may be programmed online or offline. to learn more about using the Arduino software.

Vehicle Detection Method*Design Implementation*

Video surveillance systems that use attribute-based search and vehicle detection [1] The first stage in monitoring and managing traffic, according to the research, is vehicle identification. Present-day surveillance systems employ low-resolution cameras; nevertheless, many conventional techniques, such as number plate recognition and vehicle categorisation, might not work well with these cameras. A training-based strategy to feature selection and classification is presented in this work. To identify vehicles, a Haar-based As a classification method, the models are trained using the Adaboost algorithm. Furthermore, it builds powerful classifiers by combining the output of weak classifiers that employ variations of weighted data samples. In the process of looking for a certain automobile, other attributes are also used. Features include colour, speed, direction of travel, date and time. Because of the correct information provided by these features, a more condensed list of recognised cars may be shown. Vehicle categorisation using a fast learning algorithm [2]

Vision-based methods must be used for detection since vehicle heterogeneity is so great. Environmental factors, vehicle shadows, and cluttered backgrounds are examples of nearby objects that affect an object's look. Adaboost is hence the method for vehicle detection that is most strongly advised.. This work addresses the issue by presenting a quick incremental learning vehicle categorisation system. Initially, common feature extraction methods were used, such as Principal Component Analysis (PCA) and Gabor Filter, but these were computationally laborious. This work utilises a 32x32 greyscale picture patch and

Red Light Violation Detection Method

Creating an autonomous red light violation detection system (RLVDS) for Indian automobiles This research is on the current integrated traffic management systems (ITMS) in use in India. ITMS's top goals are regulations and road safety. The approach employed in this study produces a full list of all automobiles that violate the law. First, the security camera data is utilised to extract backdrop images. If it is a background picture, this adaptive approach adds it to the stack of background images for comparison. The average of the photos is then used to find infringement. The system evaluates possible occlusions that happened over the stop-line by using the background



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subtraction technique. Beyond the zebra A simulated stop line is installed at the crossing. Furthermore, five imaginary lines on either side of the stop line—which serves as a threshold—are evaluated. If an item passes the sand-free line in the image, it is classified as a vehicle. Furthermore, the system employs optical character recognition technology to determine if the license plate belongs to a car. The device can accurately appraise up to 92% of autos. According to the Traffic Violation Detection and Penalty Generation System [4], violations of red light traffic signals are the leading cause of traffic congestion and accidents at street junctions. It's plausible given the paucity of traffic cops at each crossing. Based on video post-production techniques, this research proposes an infraction detection system for traffic control systems. Without support from other external systems, like a control box for traffic lights, the system operates on its own. The gadget recognises red light at first using video processing algorithms. After an image is captured, the red colour matrix is taken out of the RGB layer. By removing it from the grey frame, this image is transformed into a binary image. Around the red signal, a bounding box is created using the Blob methodology. In the event that a red signal is received, automobiles are identified using the Hue technique, which use the HSV colour system.

Method for Number Plate Reciprocement

A successful strategy for an automated license plate recognition system [5], Recognising the car's license plate as soon as it is observed is the next crucial action. The information about the automobile owner must be retrieved using automated number plate recognition with image processing. Numerous characteristics, such as the picture quality and retrieval time, are impacted by the accuracy of the system. In order to facilitate automated recognition, the paper divides the number plate into three parts. Three approaches exist: template matching, optical character recognition, and character segmentation. The research suggests character identification using a greyscale picture and Gabor filtering. After applying the linear Gabor filtering technique, the image's high level of noise was removed. The Greyscale picture is split up into personas. The licence number is divided into many characters. Next, using format comparison, the characters are connected pixel by pixel. OCR takes less time and produces more accuracy with the suggested approach, which has been observed to yield good results. Adaboost is a classification tool when it comes to Haar-like feature extraction. found the accuracy of the vehicle detection. An alert is delivered to the RTO unit when the same vehicle runs a red light twice.

Flowchart for Solution Proposed

Using the present OpenCV Python source code, we will create a new system that combines the ability to query a database for the identification of a certain plate number defaulter with a web page that shows the result of the recorded plate number. A database comprising all of the car license plates will be searched in order to determine who is in default. The system that has been developed will employ affordable methods to provide satisfying results while utilising a logical and effective strategy to identify automobiles that move swiftly. It may be quite challenging to take photographs of moving automobiles in real time that allow for the identification of the number plate number. The systems that are now in use and were previously mentioned have employed a variety of techniques for obtaining plate numbers. Most of them succeeded in snagging the license plates of swiftly travelling cars. The study that most nearly matched this one used OpenCV and Python to recognise the number plate number, but it lacked a database system to identify the perpetrator.

Working Principle

Installing the vehicle data transmitting card, made with an 89C2051 microprocessor, into the car is the first stage in the procedure. With only twenty pins, this chip is a tiny gadget that takes up incredibly little space. Consequently, A little toy truck serves as the home for the data transmission card. Using a preprogrammed microprocessor that consistently provides the same data, the car's controller creates digital information relevant to the vehicle. The digital data of the controller is modulated at a frequency of 38 KHz. This frequency cannot be transmitted as a modulated wave; instead, the controller's data must be superimposed onto it. How frequently it happens The timer chip functioned as a carrier, creating a modulated pulse by combining an infrared LED. An oscillator's digital data from the controller. The controller generates digital data, which is sent via an infrared LED. The use-case diagram (figure 4.2 below) shows how the project is currently moving. In addition to the image-based input flow into the PC, the user provides the raw dataset as input. To analyse and improve the cluster data,





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the system analyses and processes the dataset, extracting the relevant dataset. The system generates a forecast based on the provided data cluster by charting the data values and displaying the refined output precisely as it appears on the show screen. Hence, in this manner, we are able to identify the cars that have been violated and forward the vehicle information to the local police.

CONCLUSION

The project work titled "IoT-based Signal infringed on the vehicle detector" has been completed successfully, and the results are considered acceptable. We found out on our trail runs that it might be difficult to transfer data from the automobile. because the necessary sensors and circuitry won't be accessible. By experimenting with several circuits and eventually achieving the desired result, we have, in this sense, designed our own circuit. Ultimately, this circuit aims to transmit the digital information produced by the microcontroller chip. One significant problem we found when we initially planned to broadcast the data using an RF transmitter is that the car begins providing data before the circuit reaches the zebra line. The goal is to send data at the vehicle's zebra line crossing. In circumstance, when the red light is activated. We found that in this respect, data delivery is required to be unidirectional rather than omnidirectional, as is the case with RF transmitters. Accordingly, an IC 555 is used to build an IR signal transmitter circuit. IOT technology is a significant player in communication and is predicted to be one of the fastest-growing industries in the years to come. By sharing the data from different devices, IOT facilitates human connection. Recent advancements in wireless sensor networks have given rise to a new internet of things trend. This research aims to investigate effective techniques for locating cars that have ignored traffic signals.

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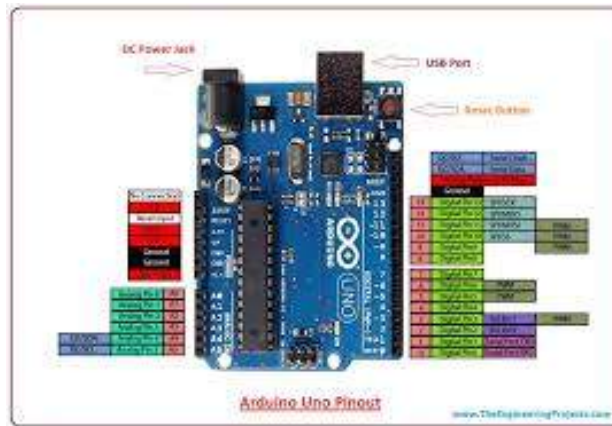


Fig 1: Arduino



Fig 2: LCD



Fig 3: Voltage-Regulator

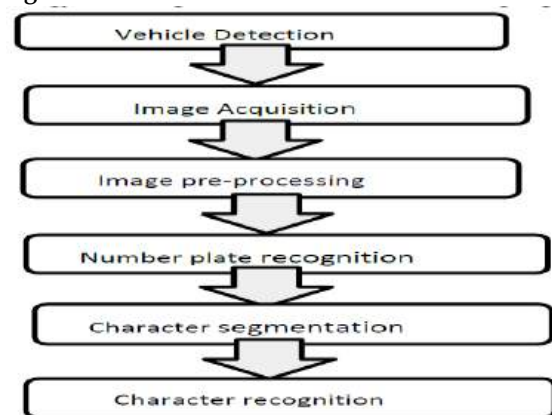


Fig4: Flow diagram for the design process.

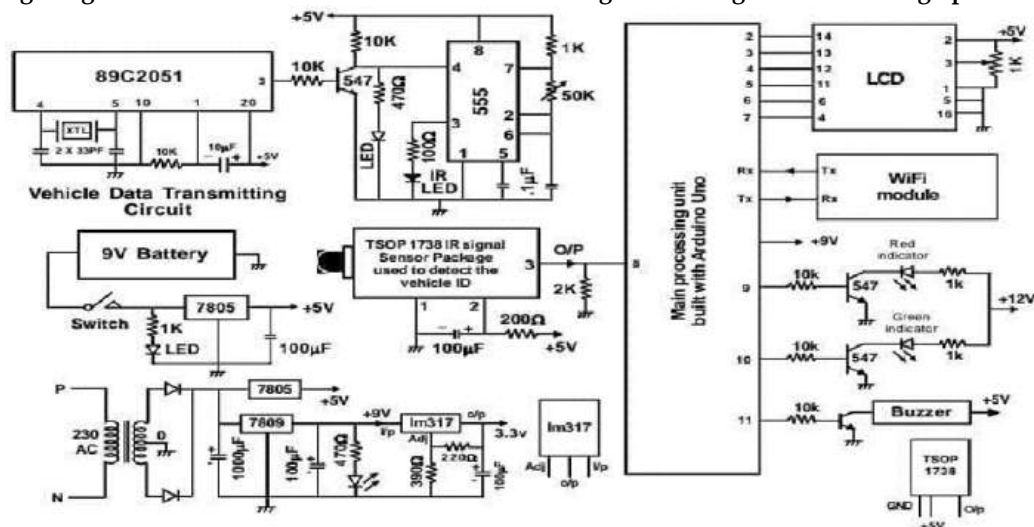


Fig 5: IoT Based Vehicle detector





Benzene Molecular Structure and Its Use in Cosmetic Industry

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ABSTRACT

Composed of six carbon atoms with alternating single and double bonds, benzene is a very stable aromatic hydrocarbon with a planar, hexagonal molecular structure that forms a conjugated π -electron system. C_6H_6 is its chemical formula. Because of its remarkable stability due to electron delocalisation, benzene is an essential component of organic chemistry. Benzene is a recognised carcinogen while being used extensively in industry, and its presence in consumer goods—especially cosmetics—has sparked serious health concerns. Benzene is not purposefully introduced to formulas in the cosmetics industry, although it may show up as a contaminant in some substances like petroleum-based compounds or propellants for aerosols. Benzene contamination may happen during production, particularly in items that often need intricate chemical reactions, such as body sprays, sunscreens, and dry shampoos. Even very small levels of benzene exposure have been related to major health hazards, such as leukaemia and other blood diseases. The abstract delves into the chemical structure of benzene, examines its unintentional inclusion in cosmetics, and deliberates on regulatory actions designed to curtail its prevalence in order to protect consumer health. The abstract also examines detection techniques already in use and the industry's effort for safer substitutes that promote formulations devoid of benzene.

Keywords: Benzene, molecular structure, cosmetic industry

INTRODUCTION

Benzene is a colourless, extremely flammable liquid with an aromatic hydrocarbon formula of C_6H_6 . It has a pleasant Odor. Six carbon atoms are grouped in a planar hexagonal ring to make up the structural makeup of benzene. The carbon atoms alternate between single and double bonds [1]. The aromatic characteristics of benzene are derived from delocalized π -electrons that stabilize this structure. Despite being extensively used in industrial settings because of its capacity to dissolve different materials, benzene's carcinogenic and poisonous properties have drawn attention [2]. Benzene is not a purposeful element in cosmetics, but since it is present in propellants and solvents, it



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may sometimes be detected as a contaminant in personal care products, especially sprays, sunscreens, and hand sanitizers [3]. Leukaemia and other blood problems are among the serious health dangers associated with continuous exposure to benzene, even at low levels, which has prompted regulatory concerns [4]. With the chemical formula C_6H_6 , benzene is an aromatic hydrocarbon with six carbon atoms bound to six hydrogen atoms in a ring. Benzene is special because its conjugated ring structure is stable due to the delocalized π -electrons. This provides benzene with comparable C–C bond lengths and planar, hexagonal structure, essential to its chemical reactivity. Because of its aromaticity, benzene is a fundamental building block in organic chemistry and is often used as a precursor for other molecules. Although its high toxicity restricts its direct usage, particularly in consumer items, its stability and reactivity make it suitable for synthesizing more complicated compounds.[5] Despite being known to cause cancer, benzene has sometimes been found in cosmetic goods due to contamination or as a by-product of raw materials used in production. Given that prolonged exposure to benzene may result in leukemia and other blood problems, its presence in cosmetics has sparked worries about possible health risks. Manufacturers are advised to reduce the amount of benzene in their products, even if the FDA has established restrictions on its content. Processes using solvent extraction, aerosol propellants, or contamination in raw materials like butane, iso-butane, or ethanol may introduce benzene into the supply chain [6]. The cosmetics sector is being investigated for possible benzene contamination, and several recalls have been started to ensure safety regulations are followed. Research indicates that to avoid benzene contamination, tighter quality control measures must be used during the manufacturing of cosmetics and personal hygiene items [7]. The research aims to develop safer substitutes for benzene and enhance production procedures to prevent contamination. Ensuring raw material purity involves enforcing stricter rules on suppliers and using greener solvents. Advancing analytical methods for identifying benzene traces offers better consumer protection [8].

METHODOLOGY

Examine research on the chemical structure of benzene, including its aromatic ring, resonance stability, and how its structure influences certain physicochemical characteristics. Examine safety evaluations and toxicology studies about benzene's carcinogenicity, mutagenicity, and systemic effects, paying particular attention to skin exposure via cosmetics or inhalation. Examine rules about benzene limitations in cosmetics issued by regulatory agencies such as the FDA and the European Commission. Take into account that benzene is a trace contaminant in substances used in cosmetics, such as butane and iso-butane. Examine the history of cosmetic recalls and recorded incidents of benzene contamination to determine the level of risk and the appropriate regulatory actions. Look for safety studies on benzene in cosmetics from organizations like the FDA, WHO, or EU SCCS (Scientific Committee on Consumer Safety). Analyse peer-reviewed research on the benzene risk assessment of different cosmetic items (e.g., sunscreens and aerosol sprays). Evaluate the results in-depth using the literature as a guide. Emphasize the effects of benzene exposure in the cosmetics sector, the health consequences for consumers, and the steps being taken to reduce hazards. Provide an overview of the dangers of benzene in cosmetics, along with regulatory advice on safe use limits and safer substitutes.

RESULT AND DISCUSSION

A key molecule in organic chemistry, benzene (C_6H_6) is well-known for its distinctive characteristics derived from its molecular structure. The following highlights important details about the attributes mentioned in Table 1 With a molecular weight of just 78.11 g/mol, benzene is lightweight compared to many other organic compounds. Its chemical formula reveals that it comprises six carbon and six hydrogen atoms. The structure of benzene is planar and hexagonal, with a ring-like arrangement of carbon atoms. The sp^2 hybridization of every carbon result in bond angles of 120° . This shape enhances Benzene's stability and reactivity. In benzene, the length of the carbon-carbon bond is always 1.39 Å. Resonance is the reason for the equal bond length; rather than benzene having alternating single and double bonds, it is represented as a delocalized π electron cloud above and below the ring plane, spreading the electron density and improving stability. D_{6h} symmetry is shown by benzene, indicating its extremely



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symmetric nature. Its symmetry affects its physical characteristics and chemical reactivity, enabling substitution processes to occur while decreasing its reactivity compared to alkenes. Because of its resonance, the molecule may be represented by many different structures, which adds to its overall stability. This delocalization of electrons lowers reactivity and stops localized double-bond production. Because benzene satisfies Huckel's rule ($4n + 2 \pi$ electrons, where n is a non-negative integer), it is categorized as a highly aromatic molecule. Benzene, having six π electrons, exhibits distinct chemical behavior, including substitution reactions instead of the addition reactions that alkenes usually experience. In addition to giving benzene its characteristic chemical characteristics, its peculiar molecular structure also enables a wide range of uses in various sectors, including the cosmetics industry. It is essential to comprehend these characteristics to investigate aromatic compounds and their derivatives.

Benzene derivatives are important ingredients in cosmetic formulations because they help with preservation, UV protection, and improving product stability, among other things. Here, we look at the typical benzene derivatives found in cosmetics and their uses and product categories. Toluene is often used as a thinner for nail polish and mainly functions as a solvent. It works well as an element in nail care products, guaranteeing a smooth and uniform application because of its capacity to dissolve other chemicals.[9] Adhesives and nail polishes often contain toluene. However, its usage is restricted in many areas owing to health concerns about its toxicity. Preservatives called parabens are often used in cosmetics to stop microorganisms from growing and to increase shelf life. Due to their ability to effectively combat various bacteria and fungi, they are widely used in different formulations.[10] Typically, lotions, creams, and shampoos include them. Though effective, parabens have come under fire for possible endocrine disruption; as a result, several firms now offer paraben-free options. As UV blockers, benzophenones shield the skin from damaging UV rays. Their primary function is to absorb UV rays and keep them from permeating the skin, avoiding sunburn and skin damage. These substances are often included in lip balms and sunscreens, where they improve the effectiveness of sun protection products. As an antioxidant, BHT prevents oils in cosmetic compositions from becoming rancid. BHT increases the product's shelf life and aids in quality maintenance by stabilizing it. It is often used in moisturizers and lipsticks, where the retention of oils is essential to preserving efficacy and texture. This substance contributes to sunscreen creams' sun protection factor (SPF) by acting as an absorber of UV radiation. It aids in keeping other UV filters from deteriorating. It is mostly present in sunscreen creams, strengthening its ability to block UV rays. Benzene derivatives are essential to cosmetics because they improve product performance, guarantee stability, and provide the required protection. Nonetheless, further study and public education are necessary, given these substances' safety and legal standing.

A volatile organic chemical known for its detrimental effects on health, including carcinogenicity and toxicity to reproduction, is benzene. As a result, strict limits have been created by regulatory bodies to restrict its use in cosmetics and personal hygiene products. The FDA has established a maximum permitted level of benzene in cosmetics of 2 parts per million. This restriction is intended to reduce exposure hazards while permitting the use of items that could contain traces of benzene as a contaminant.[12] The serious health concerns associated with benzene have been brought to light by agencies like the Centres for Disease Control and Prevention (CDC) and the World Health Organisation (WHO). Its designation as a recognised human carcinogen emphasises how crucial it is to control its inclusion in consumer goods in order to safeguard the general public's health. By outlawing its usage in cosmetic products, the CIR has shown its strong position against benzene. Scientific data supporting the possibility of major health effects from benzene has prompted regulatory agencies in the USA and the EU to strictly enforce these limits, which is why this decision was made.[13] Toluene and parabens are examples of benzene derivatives that are allowed in certain amounts while pure benzene is prohibited. Because of their solvent and preservation qualities, these compounds are often used in cosmetics; nonetheless, strong regulations are in place to protect the public. [14]





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CONCLUSION

The study of the molecular makeup of benzene and its accidental entry into the cosmetics sector highlights the crucial relationship between public health, consumer safety, and chemistry. Because of its stability and special qualities, benzene is an essential part of many industrial processes; nevertheless, since it is a carcinogen, its use in consumer goods has to be reconsidered. Although benzene isn't purposefully introduced to cosmetic formulas, customers are still in serious danger from its contamination due to using petroleum-based chemicals and production techniques. Although regulations have been implemented to lessen these hazards, maintaining public health still depends on compliance and enforcement. The industry's capacity to detect and measure the amount of benzene in cosmetic items is being improved by the ongoing evolution of current detection techniques. Formulations devoid of benzene are becoming increasingly popular as consumer awareness rises, and there's a growing need for transparency and safer options. In summary, producers, regulators, and consumers all need to work together to solve the issues of benzene contamination in the cosmetics business. In addition to safeguarding consumer health, this initiative will encourage the creation of safer, more environmentally friendly cosmetics that put user health first. To secure a healthy future for the cosmetics sector, future research should concentrate on developing detecting tools and investigating alternative chemicals.

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Table 1: Benzene Molecular Structure

Property	Value
Chemical Formula	C_6H_6
Molecular Weight	78.11 g/mol
Structure	Planar, hexagonal ring
Bond Angles	120° (sp^2 hybridized carbon atoms)
Bond Length (C-C)	1.39 Å (equal bond lengths)
Bond Type	Alternating single and double bonds (delocalized π electrons)
Symmetry	D_{6h} symmetry
Resonance	Exists in resonance between two structures, stabilizing the molecule
Aromaticity	Highly aromatic, follows Huckel's rule ($4n + 2$ π electrons)

Table 2: Benzene Derivatives in Cosmetics

Benzene Derivative	Function in Cosmetics	Common Products
Toluene	Solvent and nail polish thinner	Nail polishes, adhesives
Parabens (Methyl, Propyl, etc.)	Preservatives (prevent microbial growth)	Lotions, creams, shampoos
Benzophenones (e.g., Benzophenone-3)	UV blockers (sunscreen agent)	Sunscreens, lip balms
BHT (Butylated Hydroxytoluene)	Antioxidant (prevents rancidity of oils)	Lipsticks, moisturizers
Phenyl benzimidazole Sulfonic Acid	UV light absorber	Sunscreen lotions

Table 3: Regulatory Concerns and Guidelines for Benzene in Cosmetics

Regulation/Guideline	Details	Regulatory Authority
Maximum Benzene Level Allowed	2 ppm (parts per million) in cosmetics and personal care products	FDA (USA)
Health Risks	Carcinogenicity, reproductive toxicity, skin irritation	WHO, CDC
Cosmetic Ingredient Review (CIR)	Banned use of pure benzene in cosmetics due to toxicity	EU, USA
Benzene Derivative Allowances	Derivatives like parabens and toluene are regulated but allowed in small concentrations	FDA, EU Regulations





From Screening to Survivorship: Cutting-Edge Approaches in Breast Cancer Treatment

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ABSTRACT

Breast cancer is solitary of the most rampant cancers all-inclusive, necessitating uninterrupted advancements in its detection, treatment, and survivorship care. This review discusses topical innovations in breast cancer management, including novel early detection techniques, such as digital breast to mo synthesis (DBT), liquid biopsy, and the application of artificial intelligence (AI) in mammography. Advances in treatment, particularly immunotherapy and targeted therapies like PARP inhibitors and CDK4/6 inhibitors, are smoothing personalized medication. The significance of survivorship care and addressing hereditary risk factors through genetic counseling is also explored, emphasizing the need for a holistic, patient-centered approach to breast cancer care.

Keywords: Genetic counseling, Digital breast tomosynthesis (DBT), Liquid biopsy, Multi gene panel testing, High-risk breast cancer, Antibody-drug conjugates (ADCs), Molecular breast cancer therapy.

INTRODUCTION

Breast cancer remains one of the most momentous health challenges globally and is the leading cause of cancer-related morbidity and mortality amongst women [1]. Detection rates are enhanced by these novel approaches, particularly in high-risk populations and women with dense breasts, which allows for earlier and more accurate interventions. Breast cancer treatment has evolved dramatically in tandem with improved detection methods. The incorporation of immunotherapy and targeted therapies marks a noteworthy shift from traditional chemotherapies by offering more personalized and effective treatment options. Promising results have been seen in immunotherapy, principally for antagonistic subtypes like basal-like breast cancer [2], but targeted therapies tailored to specific



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genetic profiles are redefining treatment paradigms [3]. As survival rates continue to improve, there is a growing emphasis on enhancing the quality of life for breast cancer survivors. Long-term effects of treatment, including cognitive impairments, cardiovascular risks, and psychosocial challenges, underscore the need for comprehensive survivorship care plans [4]. Additionally, advancements in genetic research, including the identification of new susceptibility genetic factors beyond BRCA1 and BRCA2, are enhancing risk assessment and personalized prevention strategies [5]. This review article aims to explore the state-of-the-art developments in breast cancer care, focusing on early detection techniques, treatment innovations, survivorship considerations, and the impact of genetic factors on risk management. By exploring these advancements, we can better understand the evolving landscape of breast cancer management and the promise it holds for improving patient outcomes.

METHODS AND MATERIALS

Literature Search Strategy

A methodical literature review was conducted to characterize relevant studies and publications on recent advancements in breast carcinoma detection, treatment, survivorship care, and hereditary risk management. The following databases were used to gather peer-reviewed articles and clinical trial data:

- PubMed
- Google Scholar
- Web of Science
- Scopus

The search terms included:

- Breast cancer detection innovations
- Digital breast tomosynthesis
- Artificial intelligence in mammography
- liquid biopsy in detecting Breast cancer
- Immunotherapy in breast cancer
- PARP inhibitors
- CDK4/6 inhibitors
- Breast cancer survivorship care
- BRCA mutations in breast cancer
- Hereditary

Early Detection Techniques

Novel Screening Technologies

Premature detection is crucial in improving breast cancer survival rates, and several advanced screening methods have been developed to enhance traditional approaches.

Digital Breast Tomosynthesis (DBT)

DBT, or 3D mammography, improves upon traditional 2D mammography by creating three-dimensional images of the breast. This technology significantly increases the detection rate of invasive cancers, particularly in women with dense breast tissue, and reduces false-positive recalls [1].

Contrast-Enhanced Spectral Mammography (CESM)

CESM uses intravenous contrast agents to highlight areas with increased blood flow, a common indicator of malignancy. It is particularly useful for high-risk patients and women with dense breasts, as it can detect cancers that might be missed by conventional mammography [2].

Artificial Intelligence (AI) in Mammography

AI and machine learning algorithms are increasingly used to assist radiologists in interpreting mammograms. AI systems can improve detection accuracy, reduce false positives, and streamline diagnostic workflows, providing a valuable tool to enhance human decision-making in breast cancer screening [3].



Kanakala Prathibha Malini *et al.*,**Liquid Biopsy**

Liquid biopsy represents a promising non-invasive technique for detecting and monitoring breast cancer. By analyzing circulating tumor DNA (ctDNA) and circulating tumor cells (CTCs) in blood samples, liquid biopsy offers the potential for early diagnosis and personalized treatment adjustments based on real-time tumor genetics. Although still under development, it holds significant promise for earlier, less invasive detection and monitoring of breast cancer [4].

Advances in Breast Cancer Treatment

Immunotherapy

Immunotherapy has gained attention in breast cancer management, particularly for aggressive subtypes such as triple-negative breast cancer (TNBC) [5].

Checkpoint Inhibitors

Drugs like atezolizumab (Tecentriq) and pembrolizumab (Keytruda) block immune checkpoint pathways that tumors exploit to avoid detection by the immune system. When combined with chemotherapy, these drugs have shown improved outcomes, particularly in patients with metastatic TNBC [6].

CAR-T Cell Therapy

CAR-T cell therapy involves genetically modifying a patient's T cells to target specific antigens on cancer cells. Though still in its early stages for breast cancer, early clinical trials show promise in treating HER2-positive breast cancer [7].

Antibody-Drug Conjugates (ADCs)

ADCs are precision therapies that deliver cytotoxic agents directly to cancer cells. Trastuzumab deruxtecan (Enhertu) has demonstrated efficacy in HER2-positive breast cancer, targeting cancer cells while minimizing damage to healthy tissue [8].

Targeted Therapies

Personalized treatment based on the genetic makeup of tumors has led to the development of targeted therapies that offer more effective and less toxic options compared to traditional chemotherapy.

PARP Inhibitors

PARP inhibitors such as olaparib (Lynparza) and talazoparib (Talzenna) are particularly effective for patients with BRCA1 or BRCA2 mutations. These drugs work by preventing cancer cells from repairing damaged DNA, leading to cell death and improved progression-free survival [9].

CDK4/6 Inhibitors

CDK4/6 inhibitors like palbociclib (Ibrance) and ribociclib (Kisqali) target proteins involved in cell division. These inhibitors, when combined with hormone therapy, have been shown to improve outcomes in patients with hormone receptor-positive, HER2-negative breast cancer [10].

PI3K Inhibitors

For patients with PIK3CA gene mutations, alpelisib (Piqray) targets the PI3K pathway, which is involved in cancer cell growth. When combined with hormone therapy, alpelisib has shown efficacy in treating advanced breast cancer [11].

Survivorship and Care

As survival rates improve, attention has shifted toward long-term survivorship care and enhancing the quality of life for survivors.

1. Cognitive Function (Chemo Brain):

Chemo brain, a condition characterized by memory lapses and difficulty concentrating, is a common side effect of chemotherapy. Research is ongoing into interventions such as cognitive training, exercise, and mindfulness practices to mitigate these cognitive impairments in breast cancer survivors [12].

2. Cardiovascular Health

Certain treatments, such as anthracyclines and radiation therapy, can increase the risk of cardiovascular disease. Cardioprotective strategies, including beta-blockers and ACE inhibitors, are being integrated into survivorship care to monitor and manage cardiovascular risks [13].





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3. Psychosocial Support

Breast cancer survivors often experience psychological challenges such as anxiety, depression, and body image issues. Incorporating mental health services, including support groups and psycho-oncology counseling, into survivorship care plans has been shown to improve emotional well-being and overall quality of life [14].

Genetic Factors: Unraveling Hereditary Risks

BRCA1 and BRCA2 Mutations

BRCA1 and BRCA2 are tumor suppressor genes that play a crucial role in maintaining the stability of our DNA. These genes are involved in the repair of DNA damage through homologous recombination. Mutations in these genes significantly raise the risk of developing breast and ovarian cancers [15].

Cancer Risk Associated with BRCA1 and BRCA2 Mutations:

- **BRCA1 Mutation:** Women with a BRCA1 mutation have a 55-72% lifetime risk of developing breast cancer and a 39-44% risk of developing ovarian cancer [16].
- **BRCA2 Mutation:** BRCA2 mutations carry a 45-69% risk for breast cancer and an 11-17% risk for ovarian cancer [17].

Other Cancer Risks:

- Both men and women with BRCA mutations also face a higher risk of pancreatic cancer and melanoma.
- Men with BRCA2 mutations are at increased risk of male breast cancer and prostate cancer [18].

Preventive Measures for BRCA Carriers:

Genetic counseling is essential for individuals with BRCA mutations. Preventive options include:

- **Prophylactic Surgery:** Preventive mastectomy and oophorectomy to lower cancer risk.
- **Enhanced Surveillance:** Frequent mammograms, MRIs, and clinical breast exams.
- **Chemoprevention:** Medications like tamoxifen or raloxifene can reduce breast cancer risk [19].

Beyond BRCA: New Genetic Insights

Recent advancements in genetic research have uncovered additional genes, beyond BRCA1 and BRCA2, that also increase the risk of breast cancer. These discoveries are enhancing the accuracy of genetic risk assessments and improving personalized prevention strategies for at-risk individuals.

Key Genes Beyond BRCA:

- **PALB2:** Mutations in PALB2 can significantly increase the risk of breast cancer, with studies suggesting a 33-58% lifetime risk [20].
- **CHEK2:** CHEK2 mutations are linked to a moderate increase in breast cancer risk, with a lifetime risk of 20-44% [21].
- **ATM:** Mutations in ATM can increase the risk of breast cancer, with lifetime risks ranging from 15-60% [22].

Multigene Panel Testing

Multigene panel testing has emerged as a powerful tool for assessing breast cancer risk by testing several genes simultaneously, including BRCA1, BRCA2, PALB2, CHEK2, ATM, and others [23].

Why Multigene Panels Are Important:

- **Comprehensive Risk Assessment:** Multigene panels offer a more complete risk assessment than BRCA testing alone.
- **Expanded Identification of At-Risk Individuals:** Multigene testing identifies individuals at risk who may not carry BRCA mutations but still have genetic mutations linked to breast cancer.

Personalized Risk Management:

Healthcare providers can offer personalized management plans based on genetic profiles, ranging from more aggressive preventive measures to tailored screening schedules [24].





DISCUSSION

The advancements in breast cancer care represent a paradigm shift toward more personalized, precise, and less invasive approaches to diagnosis and treatment. Early detection technologies, such as DBT, CESM, and liquid biopsy, are improving the accuracy of breast cancer examination, particularly for women with dense breast tissue or high genetic risk [25]. Immunotherapies and targeted therapies are expanding treatment options for aggressive or advanced cancers. Tailoring treatment based on the molecular and genetic characteristics of tumors represents a significant shift from the one-size-fits-all approach of traditional chemotherapy and radiation [26]. In terms of survivorship, addressing long-term effects of breast cancer treatment is essential for improving survivors' quality of life. Genetic research continues to refine breast cancer risk assessments, enabling more personalized prevention strategies [27-28].

CONCLUSION

The evolving landscape of breast cancer care offers hope through advancements in early detection, treatment, and survivorship. Personalized medicine and genetic research are driving more precise, effective, and less invasive options for patients, with continued innovation in screening, treatment, and survivorship care. Top of Form Bottom of Form care will be essential in further improving outcomes for breast cancer patients and survivors, ultimately working toward the goal of reducing the global burden of this pervasive disease.

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Antitranspirants in Vegetable Crop Production: Enhancing Resilience and Productivity

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ABSTRACT

Antitranspirants are chemical substances applied to plants to reduce transpiration, thereby conserving water and enhancing plant resilience, particularly in vegetable crops. These substances play a vital role in agricultural practices, especially in regions facing water scarcity and climate variability. This review discusses the different types of antitranspirants, including physical barriers, physiological inhibitors, and metabolic modifiers, along with their specific mechanisms of action. The effectiveness of these substances in improving crop yield, quality, and stress tolerance is explored in the context of contemporary agricultural challenges. Research indicates that strategic application of antitranspirants not only conserves water but also enhances the overall productivity of crops, making them particularly valuable in arid and semi-arid regions. Additionally, the review highlights the implications for sustainable agriculture, emphasizing the importance of integrating antitranspirants into broader crop management strategies. By doing so, farmers can better manage water resources, ensuring crop resilience and food security in the face of ongoing environmental changes. The findings underscore the need for further research to optimize application techniques and develop innovative formulations tailored to specific agricultural contexts.

Keywords: Antitranspirants, vegetable production, transpiration, sustainable agriculture.





INTRODUCTION

Transpiration is an essential physiological process in plants, facilitating water uptake, nutrient transport, and temperature regulation. As water evaporates from the plant surface, it creates a negative pressure that helps draw water and minerals from the roots through the xylem. This process is crucial for maintaining turgor pressure in cells, supporting metabolic activities, and ensuring optimal growth. However, excessive transpiration can lead to significant water loss, particularly in vegetable crops cultivated in regions with limited water resources. In the context of climate change, the frequency and intensity of drought conditions have increased, exacerbating water scarcity issues for farmers. Vegetable crops, which often require consistent moisture for optimal development, are particularly vulnerable to these stressors. As a result, there is a pressing need for innovative agricultural practices that enhance water use efficiency while maintaining crop productivity and quality. This challenge is further compounded by growing global populations and increasing food demand, which necessitate more efficient and sustainable agricultural practices.

Antitranspirants represent a promising solution to mitigate water loss in plants. These substances are designed to effectively reduce transpiration rates, allowing crops to conserve water and maintain productivity under drought conditions (Hassan *et al.*, 2018). By modulating stomatal behavior and enhancing plant physiological responses, antitranspirants help crops withstand water stress and continue their growth, even in challenging environments. This review aims to explore the various types of antitranspirants, their physiological mechanisms, and their practical applications in enhancing the resilience and productivity of vegetable crops. We will categorize antitranspirants into three main groups: physical barriers, physiological inhibitors, and metabolic modifiers. Each category will be examined for its specific mechanism of action, efficacy in crop production, and overall impact on plant health. Furthermore, this paper will delve into the implications of antitranspirant use for sustainable agriculture. By integrating these substances into broader crop management strategies, farmers can improve water conservation efforts and enhance crop resilience in the face of climatic fluctuations. The strategic application of antitranspirants not only contributes to water management but also plays a critical role in ensuring food security in an era marked by environmental uncertainty. In summary, this review underscores the significance of antitranspirants in contemporary agricultural practices, particularly in the realm of vegetable crop production. By enhancing our understanding of their mechanisms and optimizing their application, we can promote more sustainable farming practices that address the challenges of water scarcity and climate change, ultimately contributing to improved agricultural resilience and food security.

Types of Antitranspirants

Antitranspirants can be classified into three main categories based on their mechanisms of action: physical barriers, physiological inhibitors, and metabolic modifiers.

Physical Barriers

Physical barriers serve as protective coatings on leaf surfaces, reducing water loss by creating a barrier that limits water vapor escape. These coatings can be composed of natural or synthetic waxes, such as paraffin wax and natural wax emulsions.

Mechanism of Action

By forming a hydrophobic layer, these antitranspirants diminish the leaf's permeability to water vapor while allowing gas exchange necessary for photosynthesis. This physical obstruction is particularly useful in conditions where environmental humidity is low, as it minimizes water loss without negatively impacting photosynthetic efficiency (Mansour *et al.*, 2016).

Examples and Efficacy

Research has demonstrated that applying physical antitranspirants to crops like tomatoes and peppers can significantly reduce transpiration rates while maintaining yield and quality. Studies show that these coatings do not impede photosynthetic activity, making them a viable option for enhancing drought resilience.



**Vadada Vinay kumar *et al.*,****Physiological Inhibitors**

Physiological inhibitors directly affect plant stomata, the small openings on leaves that facilitate gas exchange and transpiration. Common physiological inhibitors include abscisic acid (ABA) and potassium salts, which induce stomatal closure and subsequently reduce transpiration rates.

Mechanism of Action

ABA is a plant hormone that regulates various physiological processes, particularly in response to stress. When applied externally, ABA can trigger stomatal closure, thereby reducing water loss and helping plants conserve moisture during periods of drought (Husain *et al.*, 2017).

Efficacy in Crop Production

Research indicates that the use of ABA in vegetable crops, such as cucumbers and leafy greens, has resulted in improved drought tolerance and yield under water-limited conditions (Badr *et al.*, 2019). In controlled experiments, ABA-treated plants exhibited enhanced relative water content and maintained higher photosynthetic rates compared to untreated controls.

Metabolic Modifiers

Metabolic modifiers enhance the plant's inherent mechanisms for stress tolerance, promoting physiological processes that help mitigate the effects of drought. Compounds such as salicylic acid and jasmonic acid are examples of metabolic modifiers that can stimulate plant responses to water stress.

Mechanism of Action

Salicylic acid, for instance, promotes antioxidant activity and enhances osmoregulation, which are critical for helping plants cope with water deficits. It has been shown to enhance the synthesis of protective proteins that contribute to drought resilience (Amani *et al.*, 2020).

Effects on Crop Physiology

Studies have highlighted that salicylic acid can improve overall plant health by enhancing root development, allowing for better water and nutrient uptake. This is particularly significant for vegetable crops like tomatoes, where robust root systems can lead to improved yield and quality under stress conditions.

Mechanisms of Action

Antitranspirants primarily function by affecting stomatal behavior, but their influence extends to other physiological processes that contribute to plant health and productivity.

Stomatal Regulation

Stomatal closure is a critical mechanism through which antitranspirants reduce water vapor loss. When plants sense water deficit, ABA levels increase, leading to rapid stomatal closure. This response is crucial for maintaining leaf hydration during dry periods (Hassan *et al.*, 2018).

Research Findings

In a study examining various vegetable crops, including carrots and spinach, researchers observed that antitranspirant application led to a significant reduction in stomatal conductance, thereby conserving water while allowing for adequate gas exchange for photosynthesis.

Leaf Temperature Regulation

Antitranspirants also play a role in regulating leaf temperature. By reducing transpiration, they help maintain optimal leaf temperatures, essential for photosynthetic efficiency. Elevated leaf temperatures can lead to stress and reduced growth rates.

Impact on Photosynthesis

Maintaining cooler leaf temperatures helps prevent photosynthetic inefficiencies that can arise during high-temperature stress. Research indicates that crops treated with antitranspirants exhibit improved photosynthetic rates, even under high ambient temperatures (Mohsen *et al.*, 2021).



**Vadada Vinay kumar et al.,****Effects on Vegetable Crops****Yield and Quality Enhancement**

Antitranspirants have demonstrated significant potential in enhancing both yield and quality in various vegetable crops. For instance, Amani *et al.* (2020) reported that applying antitranspirants to tomato plants significantly increased fruit weight and improved nutritional quality under drought conditions.

Case Studies

Tomato: In trials, tomatoes treated with antitranspirants exhibited a 20% increase in fruit weight and higher levels of vitamin C compared to untreated controls.

Cucumber: Ghaffari *et al.* (2020) demonstrated that cucumber plants treated with antitranspirants produced larger and more uniform fruits. The enhanced water retention allowed for improved nutrient uptake, resulting in a 15% increase in overall productivity.

Stress Tolerance

Antitranspirants are particularly beneficial in enhancing the drought tolerance of vegetable crops. Studies indicate that various antitranspirants can significantly alleviate the adverse effects of water stress.

Mechanism of Drought Resistance

The application of antitranspirants can lead to higher relative water content in leaves, indicating improved water retention. For example, Mohsen *et al.* (2021) found that cucumber plants subjected to drought stress and treated with antitranspirants exhibited lower leaf temperatures and higher relative water content compared to untreated controls.

Root Growth Promotion

In addition to affecting leaf physiology, antitranspirants may promote root growth. Enhanced root systems can access deeper soil moisture, which is particularly vital during dry spells. This root development contributes to overall plant resilience under drought conditions (Hassan *et al.*, 2018).

Pest and Disease Resistance

Some antitranspirants may enhance a plant's resistance to pests and diseases. Healthier plants that maintain optimal hydration and physiological function are generally less susceptible to pest attacks.

Research Insights

Raza *et al.* (2022) found that vegetable crops treated with specific antitranspirants demonstrated increased resistance to common pests such as aphids and whiteflies. This dual benefit of improved water management and pest resistance underscores the value of antitranspirants in sustainable agricultural practices.

Practical Applications in Agriculture

The successful implementation of antitranspirants in vegetable crop production requires careful consideration of several factors, including application timing, concentration, and environmental conditions.

Application Timing

Optimal timing for antitranspirant application is critical to maximize efficacy. Applications should align with anticipated water stress periods, ensuring that plants are prepared for upcoming dry spells.

Critical Growth Stages

Applications during critical growth stages, such as flowering or fruit set, can further enhance yield and quality. For instance, applying antitranspirants just before flowering has been shown to improve fruit set in tomatoes.

Concentration and Method of Application

The concentration of antitranspirants is a significant factor influencing their effectiveness. Research indicates that lower concentrations may be more beneficial for certain crops, as excessively high concentrations can lead to phytotoxicity (Mansour *et al.*, 2016).

Application Methods

The method of application—whether as a foliar spray or soil drench—also impacts absorption and effectiveness. Foliar applications are generally more common, as they provide direct contact with the leaf surfaces where transpiration occurs.





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Integration with Other Management Practices

Integrating antitranspirants into broader water and crop management strategies can further enhance their effectiveness. Combining antitranspirants with practices such as mulching, rainwater harvesting, and efficient irrigation systems can improve overall water use efficiency.

Case Example: Integrated Management

In regions vulnerable to climate change, farmers have successfully integrated antitranspirants with drip irrigation systems, optimizing water use while maximizing crop yield. This integrated approach not only conserves water but also enhances the resilience of vegetable crops to fluctuating climatic conditions.

Future Directions and Research Needs

Optimizing Application Strategies

Future research should focus on optimizing application strategies for antitranspirants, including exploring novel formulations that enhance efficacy and minimize potential phytotoxicity. Field studies examining the long-term impacts of antitranspirant use on soil health and plant physiology are essential.

Developing New Formulations

There is a need to develop new antitranspirant formulations tailored to specific crops and environmental conditions. Research should explore biodegradable options that provide sustained release without harming beneficial soil microorganisms.

Assessing Economic Viability

Economic assessments of antitranspirant use in various agricultural systems can provide insights into their cost-effectiveness. Understanding the return on investment for farmers adopting these technologies is crucial for widespread implementation.

CONCLUSION

Antitranspirants offer a promising solution for enhancing the resilience and productivity of vegetable crops in water-limited environments. By reducing transpiration rates and improving stress tolerance, these substances can significantly contribute to sustainable agricultural practices. Further research will enhance our understanding of their mechanisms and optimize their application, ensuring that farmers can effectively manage water resources in an increasingly challenging climate.

This review provides a comprehensive overview of the role of antitranspirants in vegetable crop production, emphasizing their potential in addressing the challenges posed by water scarcity and climate change. Further exploration in this area will undoubtedly contribute to more sustainable agricultural practices and improved food security.

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TMSCl as Greener and Effective Solvent for the Synthesis of Isoindole-1,3-(2H) Dione Derivatives

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ABSTRACT

This study presents an efficient and environmentally friendly approach for the synthesis of Isoindole derivatives. By employing sodium cyanate, phenol/alcohol, and TMSCl (Me₃SiCl), we have successfully achieved a significant degree of purity and yield in the synthesis of Isoindole derivatives. We have demonstrated the effectiveness of TMSCl as a mild, convenient, and efficient solvent in facilitating this transition. Additionally, the synthesis and characterisation of isoindole-1,3-(2H) dione derivatives.

Keywords: Trimethyl silyl Chloride (TMSCl), Hexahydro-1H-isoindole-1,3(2H)-diones, phthalic anhydride, phenylalanine hydrochloride.

INTRODUCTION

In recent decades, multi-component reactions (MCRs) have exhibited considerable effectiveness and efficiency as bond-forming techniques in organic, combinatorial, and medicinal chemistry, especially within the context of green chemistry. Multi-component reactions (MCRs) demonstrate significant flexibility and display atom economy, as they advance through a sequence of reaction equilibria to yield the desired final product. The critical importance of



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antibiotics poses a significant challenge to public health due to the widespread transmission of illnesses. Therefore, new strategies are required to identify and implement advanced pharmaceuticals for the control of microorganisms, which must be both effective and cost-efficient treatment options [11-13]. Given the extensive range of biological activities associated with thalidomide, isoindole-1,3(2H)dione has emerged as a focal point in drug discovery and development research, pursued for diverse objectives. This moiety is recognized as a privileged scaffold for the design of novel drug candidates exhibiting multi-target effects and various biological activities, including anti-hyperlipidemic, androgen receptor antagonism, anti-convulsant, hypoglycemic, and anti-microbial properties. This study outlines a concise method for synthesizing Isoindoles, highlighting notable yield and purity levels. The procedure involves the utilization of phthalic anhydride, a mixture of phenylalanine hydrochloride, and trimethylsilyl chloride (TMSCl).

MATERIALS AND METHODS

The melting points were verified using a Buchi B2540 microscopic melting device. The infrared (IR) spectra were acquired using a Bruker-Equinox 55 spectrophotometer with KBr pellets. The ¹H-NMR spectra were acquired using a Bruker 400 NMR spectrometer. The solvent utilized for the spectra was CDCl₃, and TMS served as the internal standard. The chemical modifications (δ) were recorded and measured in parts per million (ppm). The mass spectra were acquired using an API 2000 spectrometer. All chemicals were acquired directly from commercial sources without necessitating additional purification.

TMSCl(Me₃SiCl)

Trimethylsilylchloride, also referred to as chlorotrimethylsilane, is an organosilicon compound. The compound's chemical formula is (CH₃)₃SiCl. The chemical in question is a translucent and odorless liquid. It exhibits volatility and maintains stability in the absence of water, as illustrated in Figure 1.

General Procedure for the Synthesis of Isoindole-1, 3 (2H) dione

Scheme 1 illustrates the synthesis reaction. A 25 mL round-bottom flask contained a combination of 1 mmol of phthalic anhydride (1) and 1 mmol of phenylalanine hydrochloride (2), which was refluxed with TMSCl for 80 minutes in an oil bath at 60°C, with the reaction's completion monitored by TLC. Upon cooling to ambient temperature, the reaction mixture was transferred into ice-cold water, resulting in the precipitation of the crude product, which was subsequently filtered using a Buchner funnel, washed with water, dried, and refined using recrystallization from suitable solvents.

RESULT AND DISCUSSION

Effect of temperature on synthesis of hexahydro-1H-isoindole-1,3(2H)-dione derivatives

The reaction temperature for the synthesis of hexahydro-1H-isoindole-1,3(2H)-dione derivatives in the presence of TMSCl is 60°C, as shown in Table 1. It is noted that at temperatures below 60°C, the product yield is low and the reaction time is prolonged. We have verified that 60°C is an appropriate temperature for this reaction.

Spectral Data of hexahydro-1H-isoindole-1,3(2H)-dione

White solid, M.P. = 111–112 °C.; IR (KBr, cm⁻¹): 3453, 3054, 2982, 2938, 1772, 1705, 1444, 1405, 1378, 1352, 1296, 1260, 1228, 1164, 1137, 1076, 1040.; ¹H NMR (400 MHz, CDCl₃): 4.33 (s, 2H), 3.40 (q, 2H, J = 7.3 Hz), 2.91 (m, 2H), 2.21 (m, 2H, J = 14.5, 3.5 Hz), 1.32 (s, 3H), 1.2 (s, 3H), 1.02 (m, 3H, J = 7.3 Hz).; ¹³C NMR (100 MHz, CDCl₃): 179.8, 71.3, 34.1, 33.5, 26.0, 26.0, 23.6, 13.1.; ESI-MS m/z(%): 253 [M+H]⁺ (100).





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CONCLUSION

This scientific technique enables the synthesis of several Isoindole derivatives under typical environmental conditions. The process exhibits efficient reaction kinetics, favorable product yields and purity, cost-effective starting materials, and the lack of unwanted byproducts. Moreover, TMSCl has been identified as a highly effective reagent for synthesizing Isoindole derivatives. Currently, there is a lack of documented empirical evidence about the use of TMSCl in the synthesis of Isoindole derivatives.

Declarations

Competing interests: There are no competing interests

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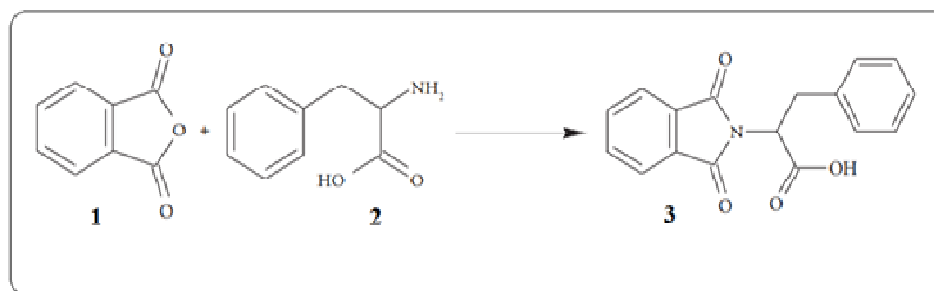
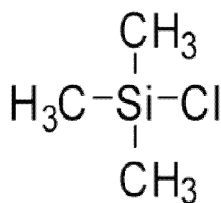


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Table 1. Effect of Temperature on the formation of hexahydro-1H-isoindole-1,3(2H)-dione derivatives

S. No.	Temperature (°C)	Time	Yield (%)
1	R.T.	10 hrs	20
2	40	6 hrs	50
3	50	3 hrs	75
4	60	80 min.	96

**Figure-1: Structure of TMSCl** **Scheme 1: Synthesis of Isoindole-1,3(2H) dione**



Cold-Source Field-Effect Transistor (CS-FET): A Review for Future Perspective

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ABSTRACT

Cold-Source Field-Effect Transistors (CS-FETs) have emerged as a promising technology to address the limitations of conventional MOSFETs in the deep-submicron regime. As transistor scaling approaches its fundamental limits, the need for devices that minimize leakage current and power consumption becomes increasingly urgent. CS-FETs leverage a novel "cold source" region to suppress thermally excited carrier injection in the off state, offering reduced leakage currents and subthreshold slopes below 60 mV/decade. This review provides a comprehensive examination of CS-FET technology, exploring its operating principles, material innovations, design architectures, and performance metrics. The potential applications, challenges, and future directions for CS-FET research are also discussed.

Keywords: Fet, Short Channel Effect, I_{on} , I_{off} , S_s

INTRODUCTION

Since the inception of Moore's Law, the semiconductor industry has focused on reducing transistor dimensions to increase performance, lower power consumption, and integrate more components into electronic devices [1]. However, as technology approaches the 7 nm and sub-7 nm nodes, further scaling of conventional MOSFETs faces significant physical and technological limitations [2], [3]. Among these challenges are increased short-channel effects (SCEs), excessive leakage currents, and thermal limitations that impact device performance and power efficiency [4]-[6]. Conventional MOSFETs suffer from a thermionic limit, which caps the subthreshold slope (S_s) at 60 mV/decade, restricting the ability to lower the supply voltage without exacerbating leakage currents [7], [8]. As a result, alternative transistor architectures are needed to meet the requirements of ultra-low-power devices such as wearable, Internet of Things (IoT) applications, and mobile processors, where power efficiency is paramount [9]. Cold-Source



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FETs (CS-FETs) offer a promising solution to this problem. They address the scaling challenges of traditional MOSFETs by suppressing leakage currents through the use of a "cold source," which limits the number of thermally excited carriers in the off state [10]-[12]. By doing so, CS-FETs can achieve sub-60 mV/decade switching and maintain a low off-state current (I_{off}) while delivering high on-state current (I_{on}) [13]. This review paper aims to provide an in-depth analysis of the design principles, performance metrics, and potential applications of CS-FETs.

Overview of Cold-Source FETs

CS-FETs employ a "cold source" to reduce off-state leakage currents by creating a low-energy source region, which limits thermally excited carrier injection [14]. This cold source can be achieved using various approaches, such as band gap engineering, material innovations, and quantum mechanical tunneling mechanisms. The primary goal of these modifications is to achieve steep subthreshold slopes ($SS < 60$ mV/decade) and significantly lower leakage currents, making CS-FETs highly suitable for ultra-low-power applications [15]-[17]. The motivation behind cold-source technology stems from the need to maintain a balance between reducing leakage current and ensuring adequate on-state current for high-performance computing. Recent studies have demonstrated that CS-FETs can achieve significant reductions in I_{off} while maintaining competitive I_{on} values, which is critical for future technology nodes beyond 7 nm [18].

Scaling Challenges in Conventional MOSFETs**Short-Channel Effects**

As MOSFETs scale to smaller dimensions, the source and drain depletion regions begin to encroach upon the channel, leading to a reduction in gate control and exacerbating SCEs [19]-[21]. SCEs result in threshold voltage roll-off, drain-induced barrier lowering (DIBL), and higher leakage currents, all of which degrade device performance [22]. CS-FETs, by leveraging a cold source, help mitigate these issues by suppressing carrier injection from the source, thereby reducing off-state leakage [23].

Gate Leakage and Thin Dielectrics

The scaling of MOSFET gate dielectrics has led to increased gate leakage due to quantum tunneling through ultra-thin oxide layers [24]. High- κ materials such as HfO_2 have been introduced to reduce leakage, but CS-FETs offer an alternative approach by minimizing the dependence on extremely thin dielectrics and focusing instead on controlling carrier injection through the cold-source mechanism [25], [26].

Power Consumption and Supply Voltage Scaling

Power consumption and supply voltage scaling in Cold Source Field Effect Transistors (CSFETs) are crucial for optimizing performance in low-power applications. CSFETs utilize a cold-source mechanism, where the source terminal is maintained at a lower temperature to reduce thermal noise and enhance device efficiency. This design allows for significant improvements in switching speeds and reduces power consumption compared to traditional FETs, particularly in low-voltage operations. Lowering the supply voltage (V_{dd}) in CSFETs can dramatically decrease dynamic power consumption, which is proportional to V_{DD}^2 . However, as voltage decreases, maintaining adequate drive current and switching performance becomes a challenge, potentially leading to slower operation and reduced noise margins. Moreover, leakage currents can become more significant at lower voltages, requiring innovative design strategies to mitigate their impact on overall power consumption.

To enhance performance while scaling down voltage, researchers are investigating advanced materials and fabrication techniques that improve electrostatic control and reduce leakage. Circuit design innovations, such as adaptive voltage scaling and power gating, are also being explored to optimize power management. Ultimately, CSFET technology holds promise for the development of next-generation low-power electronics, enabling efficient operation without compromising performance in increasingly demanding applications. Lowering the supply voltage (V_{dd}) is critical for reducing power consumption, but doing so increases the leakage current due to the thermionic emission limit of traditional MOSFETs [27]. CS-FETs circumvent this problem by achieving sub-60 mV/decade switching, allowing for lower V_{dd} without a corresponding increase in I_{off} [28], [29].



**Sukanta Swain****Operating Principles of CS-FETs****Cold Source Concept**

The cold-source concept in CS-FETs aims to suppress the injection of thermally excited carriers in the off state by reducing the energy available for carrier emission from the source to the channel [30]. By engineering the source region to have a lower energy profile, CS-FETs can limit the number of carriers that can thermally overcome the source-channel barrier, thus reducing I_{off} [31].

Subthreshold Slope

CS-FETs are designed to achieve subthreshold slopes below the 60 mV/decade thermionic limit imposed by conventional MOSFETs [32]. This is made possible by utilizing tunneling or other quantum mechanical mechanisms to modulate carrier flow at the source-channel interface. The result is a steep switching behavior, allowing the device to transition from the off state to the on state with minimal voltage changes [33]-[35].

Material Innovations in CS-FETs**III-V Semiconductors**

The use of III-V semiconductors in CS-FETs has been shown to improve device performance by providing higher carrier mobility and facilitating efficient tunneling at the source-channel interface [36]. Materials such as InGaAs and InAs have demonstrated excellent performance in CS-FET architectures, offering high I_{on} while maintaining low leakage [37], [38].

2D Materials

2D materials, such as graphene, MoS₂ and transition metal dichalcogenides (TMDs), are also being explored for use in CS-FETs due to their exceptional electrical properties and scalability [39]. These materials enable the creation of ultra-thin channel regions and allow for effective cold-source engineering, reducing both leakage and power consumption [40], [41].

Heterostructures

Heterostructure-based CS-FETs leverage the band alignment between different materials to enhance tunneling and reduce leakage [42]. By carefully designing the source-channel heterojunction, it is possible to achieve superior switching characteristics while maintaining high on-state performance [43]-[45].

Performance Metrics**Subthreshold Slope (SS)**

Achieving a subthreshold slope below the thermionic limit is one of the key performance advantages of CS-FETs. Studies have demonstrated that CS-FETs can achieve SS values below 60 mV/decade, significantly improving switching speed and power efficiency [46]-[48].

Off-State (I_{off})

One of the primary goals of CS-FETs is to reduce off-state leakage currents. Research has shown that CS-FETs can reduce I_{off} by several orders of magnitude compared to conventional MOSFETs, making them highly suitable for low-power applications [49]-[51].

On-State Current (I_{on})

Maintaining high on-state current (I_{on}) is essential for high-performance logic circuits. CS-FETs, especially those using III-V or 2D materials, can achieve I_{on} values comparable to or exceeding those of state-of-the-art MOSFETs [52]-[55].

Design Variants and Architectures**Cold-Source Tunneling FET (CS-TFET)**

Cold-Source Tunneling Field Effect Transistors (TFETs) represent a significant advancement in low-power electronics by leveraging quantum tunneling to achieve efficient switching at reduced supply voltages. Unlike conventional MOSFETs, which rely on thermal excitation to switch on, Cold-Source TFETs utilize a cold-source mechanism that maintains a lower temperature at the source terminal. This design minimizes thermal noise and enhances device stability, allowing for faster switching speeds and lower power consumption. The key operating



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principle of Cold-Source TFETs is based on band-to-band tunneling, which occurs when the energy bands are aligned appropriately, enabling carriers to tunnel from the valence band of the source to the conduction band of the channel. This results in a steep subthreshold swing, often approaching the theoretical limit of 60 mV/decade at room temperature, making these devices particularly suitable for low-voltage applications[57]-[60]. As a result, Cold-Source TFETs are promising candidates for future ultra-low-power devices, such as portable electronics and IoT applications, where energy efficiency is crucial. Ongoing research aims to optimize their performance, enhance material compatibility, and develop scalable fabrication techniques, paving the way for their integration into next-generation semiconductor technologies.

Cold-Source MOSFETs

Cold-Source MOSFETs (CS-MOSFETs) are an innovative transistor design that aims to enhance performance and efficiency by maintaining a lower temperature at the source terminal. This cold-source configuration reduces thermal noise, which is particularly advantageous in high-frequency and low-power applications. By leveraging materials with superior thermal and electrical properties, such as graphene or other advanced semiconductors, CS-MOSFETs can achieve higher electron mobility and lower resistive losses. This results in improved switching speeds and reduced power consumption, making them ideal for portable and energy-efficient devices. Additionally, CS-MOSFETs exhibit better electrostatic control, which helps mitigate short-channel effects and leakage currents, thereby enhancing overall device reliability[61]-[63]. As research progresses, CS-MOSFET technology holds great promise for next-generation electronics, particularly in areas requiring high performance and energy efficiency.

Hybrid CS-FET Architectures

Hybrid Cold Source Field Effect Transistor (CS-FET) architectures integrate traditional semiconductors like silicon with advanced materials such as graphene or transition metal dichalcogenides (TMDs) to enhance performance, reduce power consumption, and improve thermal management. The cold-source mechanism minimizes thermal noise, allowing for efficient operation, particularly in low-voltage applications, while improving gate control over the channel helps mitigate short-channel effects and leakage currents. These architectures offer higher on-state currents and better subthreshold swing characteristics, making them ideal for low-power electronics, high-frequency RF applications, and complex systems on chips (SoCs). However, challenges such as material compatibility, fabrication complexity, and thermal management must be addressed to fully realize their potential[64]-[66]. Overall, hybrid CS-FETs represent a promising avenue for advancing semiconductor technology, aiming to meet the demands of next-generation electronic devices.

Applications**Low-Power Electronics**

CS-FETs are ideal for low-power electronics, including mobile devices, IoT sensors, and wearable technologies. Their ability to operate at low voltages while minimizing leakage currents makes them a promising candidate for energy-efficient electronics [67], [68].

High-Performance Computing

In addition to low-power applications, CS-FETs offer potential in high-performance computing environments, where minimizing power consumption while maintaining high throughput is critical. Advanced CS-FET designs using III-V materials and heterostructures could outperform conventional FinFETs in terms of power and performance metrics [69], [70].

Quantum and Neuromorphic Computing

CS-FETs, with their ability to achieve steep subthreshold slopes, could play a role in the development of quantum computing and neuromorphic architectures, where energy efficiency and switching speed are critical parameters [71]-[73].

Challenges and Future Directions

While CS-FETs offer significant advantages, there are still several challenges to be addressed. These include optimizing fabrication processes for large-scale integration, reducing variability, and improving the thermal stability





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of cold-source materials. Additionally, further research is needed to explore the scalability of CS-FETs for future technology nodes beyond 3 nm [74]-[77].

CONCLUSION

Cold-Source Field-Effect Transistors (CS-FETs) present a promising solution to the scaling and power efficiency challenges faced by conventional MOSFETs. By utilizing a cold-source region, CS-FETs can suppress leakage currents and achieve subthreshold slopes below 60 mV/decade, making them highly suitable for ultra-low-power and high-performance applications. Material innovations, such as the use of III-V semiconductors, 2D materials, and heterostructures, further enhance the performance of CS-FETs, positioning them as a key technology for future semiconductor devices.

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Forensic Identification of Microorganisms in Different Water Bodies Under Microscope

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ABSTRACT

Drowning deaths are the third leading cause of unnatural deaths. According to WHO, 300000 deaths are due to drowning which is a significant high number indicates the serious need of investigations. Currently, diatom analysis is the method used for the investigation of drowning deaths. When a human body loss its life, it starts oozing the body fluids out into the surroundings which makes the water bodies to be polluted and causing a serious illness to the people dependent on those water bodies for their survival. Different microorganisms will proliferate from a dead body at each stage of its decomposition. The current study focuses on the identification of the microorganisms that are present in the water bodies of drowning deaths using a simple staining technique at different time intervals and to differentiate the origin of microorganisms whether its from water bodies or the dead body. This microbial analysis is also useful to identify the stage of decomposition and time scene of death in drowning cases.

Keywords: Water Bodies, Blowflies, Drowning deaths, Death Investigations, Entomology, Forensic Science

INTRODUCTION

Drowning deaths are one of the leading causes of homicides and accidental deaths among different age groups. The high rate of mortality signifies the damage of water bodies with the dead species increases the risk of health for the people dependent on those water bodies (1,2). The World Health Organization (WHO) ratified the new definition at the inaugural World Congress on Drowning in 2002, stating, "Drowning is the process of experiencing respiratory impairment from submersion or immersion in liquid" (3). The World Health Organization (WHO) characterized drowning as one of the leading five causes of mortality in children ages 1 to 14 years and among the top 10 causes of



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mortality in children and adolescents between the ages of 1 and 24 years. Homicidal drowning constitutes 20% of all homicide incidents in the United States. Among the lethal drownings, the majority of Instances involve children drowned by their parents or spouses. submerged by their spouses in a bathtub (4). Data from the Federal Bureau of Investigation (FBI) states documented 907 fatalities due to homicidal drowning. In a span of 21 years, 416 cases, constituting 45%, were recorded. seen below the age of eight years, succeeded by college 117 students (12%) are aged between 18 and Twenty-four years (5).

Human microbiome links individuals to the objects they touch. *Propionibacterium* and *staphylococcus* bacteria are found near sebaceous sites of the human body when the body is in live condition. *Corynebacterium* is present near moist sites of the human body. *Proteobacteria* and *flavobacteria* are found near the dry sites of the human body (6). But when the person dies the microorganisms that are present in skin flora change to *staphylococcus*, *Micrococci* and *diphtheroid* (7). Apart from these, the growth of microorganisms varies among different body parts at different conditions of life (Live and Dead) as mentioned in the table 1. All these different microbes are releasing out from the dead body into the water bodies making them unsuitable for human consumption. The current research is focused to identify the microorganisms that are found in the water bodies containing dead body and relating them to the estimation of time scene death and determining the origin of the microorganisms that are isolated.

Materials and Methods

The main objective of the study is to identify microorganisms in different water bodies (pond, river and ocean) at different time intervals (i.e. at live condition, immediately after death, after 6 hours of death and 24 hours of death of the body) and to identify the type of microorganisms that are usually found in human body (i.e. under alive condition) and dead body (i.e. after death) for differentiating the origin of microorganisms whether it's from water bodies or the dead body. For this study, the samples have been collected as the river water sample is collected from Vizianagaram district of the Gokapeta region (S1). The ocean water sample has been collected from RK beach of Visakhapatnam region (S2). The pond water sample is collected from Vizianagaram district of Balaji junction region (S3). The water sample was collected in clean and dry plastic container. Then it was covered with a foil paper and was kept under laboratory conditions for further study. A total of 12 agar plates were prepared for present study. Four plates were prepared for single water sample. Among the four plates, one plate is streaked when the fish is alive, second plate has been streaked immediately after the death of a fish, the third plate is streaked after 6 hours of death of the fish and the fourth plate has been streaked after 24 hours of the death of the fish. After streaking of the plates, the agar plates were placed in the incubator for growth of the bacteria for 24 hours at 37 °C and the process was followed by smear preparation and staining of the colonies over the glass slides. The stained slides were observed under a compound microscope at 45x magnification.

RESULT

The test samples (fish is considered as a body) are kept in 250 ml of water and allowed them to survive in that condition to minimize the occurrence of artificial death. The water samples were collected when the test sample is in live condition and marked them as sample 1 (RS1, OS1, PS1) respectively. Further water samples were collected when the test sample is died immediately and marked them as sample 2 (RS2, OS2, PS2) respectively and the another water samples were collected after 6 hours of death and marked them as sample 3 (RS3, OS3, PS3) respectively and the final water sample were collected after 24 hours of death and marked them as sample 4 (RS4, OS4, PS4) respectively. All the collected samples from sample 1 to sample 4 were incubated at 37°C for 24 hrs. The samples were inoculated on the prepared agar plate and incubated for 24 hours at 37°C allowing the cultures to grow. The cultured microbes were identified and isolated for the smear preparation. The microbes that are identified from the test were listed in the table 2





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DISCUSSION

Immediate sampling of water shows the presence of *Bacillus* and *Staphylococci* bacteria in the pond water, *Enterobacteraceae* in Ocean water and *Streptococcaceae* bacteria in River water. These micro-organisms are showing its presence in the sampling slides because *Bacillus*, *Streptococcaceae*, *Staphylococcus*, and *Enterobacteraceae* bacteria are produced by the dead body immediately after death (11, 12). Visualization of the samples after death of 6 hours under microscope reveals the presence of *Streptococcaceae* bacteria in a pond water sample, *Vibrio* bacteria in Ocean water sample and *Bacillus* bacteria in River water. This is because, the human body contains *Streptococcaceae* bacteria in the oral cavities of the living body that might be releasing into the water bodies in the process of decomposition and the *Vibrio* bacteria and *Bacillus* bacteria is producing by the dead body.

Visualization of the samples after death of 24 hours under microscope reveals the presence of *Bacillus* bacteria in Pond water, *Mycoplasmataceae* bacteria in Ocean water and *Bacteriodes* bacteria in River water. All the three mentioned bacteria's are not found in the human body at living conditions. That makes the bacterial species of *Bacteriodes* and *Mycoplasmataceae* are more specific bacterium that are found in the dead bodies. Therefore, the presence of those bacteria in the water bodies are the significant proof for the identifying the water pollution by the dead bodies.

CONCLUSION

The current research clearly shows the importance of microbial analysis in ascertaining the various source of microbes (bacteria) in drowning incidents. The study effectively detects particular microorganisms that appear in aquatic environments at various post-mortem intervals, distinguishing between indigenous waterborne bacteria and those released from decomposing corpses. The research establishes a correlation between specific bacterial species and the decomposition process, so rendering microbial profiling an essential instrument in forensic inquiries. This method assists in establishing the time of death and evaluating water contamination.

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Table 1: Identification of microbes in different body parts of human and dead body

S.N	Body Part	Bacteria in Live Condition	Bacteria in Dead Condition
1	Oral Cavity	<i>Veillonellaa typica</i> , <i>streptococcus mutans</i> and <i>streptococcus salivarius</i>	<i>Proteobacteria</i> , <i>Firmicutes</i> , <i>Actinobacteria</i> – Day 1 <i>Streptococcal anaerobes</i> – Day 2 (8)
2	Ocular Surfaces	<i>Corynebacterium</i> , <i>Pseudomonas</i> , <i>bradyrhizobium</i> , <i>Acinetobacter</i> , <i>brevundimonas</i> , <i>aqua bacterium</i> and <i>methy bacterium</i> , <i>Pseudomonas</i> , <i>Bradyrhizobium</i> , <i>Acinetobacter</i> , <i>Brevundimonas</i> , <i>Aquabacterium</i> , <i>Sphingomonas</i> , <i>Streptophyta</i> , and <i>Methylobacterium</i> (9, 10)	<i>Peptococcus</i> , <i>cephalonsporium</i> , <i>fusarium</i> <i>haemophilus</i> , <i>staphylococcus</i> (11).
3	Gastrointestinal tract	<i>E.coli</i> , <i>E.faecium</i> , <i>Acidophilus</i> , <i>F. prausnitizii</i> (12)	<i>clostridia</i> , <i>helicobacter pylori</i> , <i>klebsiella</i> , <i>enterobacteria</i>
4	Urogenitalflora	<i>Lactobacilluscrispatus</i> , <i>lactobacillusinnens</i> (13)	<i>e.coli</i> , <i>candidaalbicans</i>

Table 2: Identification of Microbes in different water bodies (River, Ocean, Pond)

S.NO	SAMPLENAME	SPECIESNAME	WATER SAMPLE
1	RS1	<i>Amoeba</i>	RIVERWATER
		<i>Paramecium</i>	
2	RS2	<i>Subtilis</i> , <i>rhodobacter</i>	
		<i>Staphylococcus</i>	
3.	RS3	<i>Streptococcusmitis</i>	
4.	RS4	<i>Subtilis</i>	OCEAN WATER
		<i>lactobacillus</i>	
5.	OS1	<i>Amoeba</i> <i>Paramecium</i>	
6.	OS2	<i>Serratiamercescens</i>	
7.	OS3	<i>Vibrio</i> <i>cholerae</i>	
8.	OS4	<i>Mycoplasma</i>	PONDWATER
9.	PS1	<i>Serratiamercescens</i>	
10.	PS2	<i>Streptococcusviridians</i>	
11.	PS3	<i>Subtilis</i>	
12.	PS4	<i>Bacillus</i> <i>cereus</i>	
		<i>Beggiatoa</i> and <i>crebnothrix</i>	





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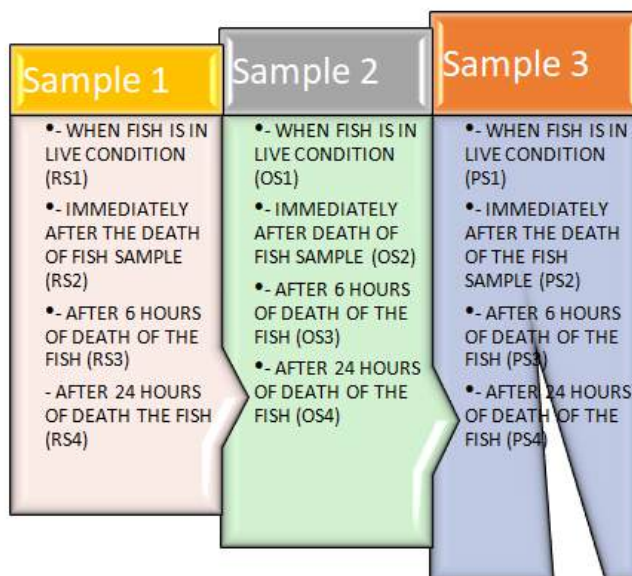


Fig 1: Research method outline of the study





Optimizing Big Data Analytics with Fuzzy Logic and Machine Learning in AI Contexts

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ABSTRACT

Specifically designed for big data business analytics, we provide a unique method in this work that integrates fuzzy logic with machine learning techniques to categorize and forecast employee compensation levels. Our technology provides useful insights into corporate operations and facilitates data-driven business planning by utilizing approaches from data science, data mining, artificial intelligence, mathematics, and statistics. With this strategy, the public and private sectors may both offer competitive pay, luring and keeping outstanding personnel. Our study shows that our approach is successful in precisely identifying and forecasting compensation levels, which improves decision-making in intricate corporate contexts powered by artificial intelligence.

Keywords: fuzzy systems, fuzzy logic, data science, categorisation, artificial intelligence, machine learning, business processes, predictive analytics, pay levels, and business analytics

INTRODUCTION

Creating company Intelligence (BI) tools to evaluate past performance, examine corporate data, and direct future company strategy is the goal of business analytics.

Some important forms of business analytics are:

Decision Analytics: Offers useful information to assist in making decisions. Recaps and characterizes historical business processes using Descriptive Analytics.

Predictive Analytics: Forecasts subsequent business conditions or results.

Prescriptive Analytics: Provides suggestions or paths for further action.



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Typically, business analytics makes use of methods from statistics, mathematics, artificial intelligence (AI), data science, data mining, and machine learning. To learn more about how well corporate processes are running, these techniques are used on huge datasets. Business processes provide an organized perspective of how activities are carried out and how personnel cooperate. They reflect the multiple complicated tasks carried out inside a business. Additionally, helpful in managing, designing, and strategically planning corporate operations is this examination of business processes. Large-scale data collecting from a range of sources may now be done quickly and effectively because to developments in AI systems. These huge databases hold important, frequently undiscovered insights. It is possible to find implicit, previously undiscovered, and maybe important information by using data science approaches like data mining and artificial intelligence.

Typical AI and data mining tasks include:

Finding recurrent patterns in data is known as **Frequent Pattern Mining**.

Grouping data without pre-labelled outcomes is known as **unsupervised learning** and **clustering**.

Utilizing labelled data analysis to forecast future results is known as **Supervised Learning**.

Numerous settings, including social media and cloud computing platforms, are suitable for carrying out these duties. The usefulness of these tasks has been greatly increased thanks in large part to fuzzy theory. Two important types of big data are corporate and employee data. Workers are essential to the way that most firms run. Salary levels are one important aspect among several that affect hiring and retaining employees. We tackle this social science problem in our work by concentrating on employee pay scale categorization and prediction. This research's primary contribution is a machine learning methodology that uses fuzzy logic to classify and predict employee pay levels. To improve prediction accuracy, fuzzy logic is included into machine learning through the use of decision tree induction techniques such as C4.5. Large dataset analysis in intricate AI-driven business analytics contexts is supported by this method. The growing problem of economic inequality, which has been continuously rising in many nations, is the driving force behind this initiative. The wealthiest people are getting richer while the lowest income groups are getting poorer. Challenges including less opportunities for social mobility, slower economic growth, and perhaps unstable society might result from this growing divide. Because of this, pressure is mounting on the public and commercial sectors to step in and assist individuals with lower incomes. Factors including an individual's work, place of living (rural or urban), health state, and greatest degree of education are considered in this study. Finding out which of these factors has the biggest bearing on a person's pay is our aim.

A worker's salary is the amount of money that their employer pays them for their completed task. An hourly rate, yearly salary, or a fixed price per work can all be used to evaluate wages. Usually, they receive payment every day, every week, every two weeks, every half month, or every month. Our objective is to identify the elements that are most likely to have an impact on pay scales, in addition to categorising data based on these criteria. Governments, educational institutions, and non-profit organizations (NPOs) may all benefit from this study's conclusions when tackling problems like economic disparity. These organizations can more successfully identify and assist those with lower incomes by using the results. For example, the understanding that "people with a low level of education tend to end up in low wage brackets" should motivate governments and educational institutions to collaborate in order to expand funding for post-secondary education and to launch additional bursary and scholarship initiatives. Additionally, by working with local businesses and organisations, NPOs may use this information to post employment positions, allowing candidates to gain paid experience in the field.

This paper is organised as follows:

Section II outlines the background and reviews pertinent material.

The conclusions of the evaluation are outlined in Section IV.

Linked Works

- A. Applying Machine Learning to Classification and Prediction Machine learning uses several supervised learning algorithms for prediction and classification. Associative scheduling is one of these techniques.





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Introducing Decision Trees

Back propagation via Neural Network Employing

Using k-Nearest Neighbours (k-NN)

Classifiers and Molecular Design (MG)

for lazy learning - Regression, linear or non-linear for predicting

Support Vector Machines (SVM) are part of Bayesian Networks.

Numerous real-world domains, including health informatics, have used these techniques. Using SVM, naïve Bayesian networks, decision trees, and artificial neural networks (ANN), for instance, may be used to analyse medical data and forecast chronic diseases. Similar to this, random forest and least squares SVM (LS-SVM) may be used to classify and diagnose knee-joint illnesses.

Another area where these strategies are applied in the real world is academic achievement. Researchers have utilised naïve Bayesian networks, decision tables, and the J48 classifier—an open-source Java implementation of the C4.5 decision tree method—to ascertain whether students are at risk of failing, for example. Academic professionals can more effectively identify pupils who need extra help by applying risk categorisation. Methods of prediction and classification have also been applied in a wide range of other real-world domains, including banking and business. Associative categorisation, for instance, has been used in data analytics to forecast the potential impact of storms on the stock market.

In real-world employee applications, decision trees and SVM have been used to predict employee turnover and worker performance, respectively. In this study, we use a modified version of the C4.5 algorithm to forecast and classify employee pay levels.

B. Uncertain Logic For supervised learning tasks including prediction and classification, other techniques such as fuzzy set theory, rough set theory, and fuzzy logic can be used either alone or in combination with the machine learning and data mining methods discussed in Section 2-A. Any real number between 0 and 1 or within the interval $[0, 1]$ can represent the truth value of a variable in fuzzy logic, a type of multi-valued logic. Put another way, it uses the concept of partial truth—where truth values might range from complete untruth to whole truth—to resolve ambiguity. Conversely, Boolean logic encodes the truth values of variables as either 0 or 1, representing the absolute states of true or false. Fuzzy logic operators do the following computations:

Conjunction

MIN (x, y), which ascertains the minimal value between the two fuzzy logic values, x and y .

Disjunction

MAX (x, y), which returns the maximum value between the two fuzzy logic values, x and y .

Negation: $1 - x$, denoting the complement of a fuzzy logic value x . These operators are distinct from the Boolean logic operators (AND, OR, NOT). Fuzzy sets, the foundation of fuzzy logic, are typically created with the use of trapezoidal curves or functions like the sigmoid function, $S(x) = 1 / (1 + e^{-x})$.

Our Tool

Assigning individuals to various salary bands based on both minor and significant qualities was the main objective of this study. To this end, we provide a fuzzy logic algorithm that classifies and forecasts an individual's likelihood of falling into a certain pay range. This work mainly adds two things: (a) a non-trivial modification and adaptation of the conventional C4.5 approach; and (b) the application of fuzzy logic to enhance the pay level forecast.

A. Understanding the Business Process and Data

To extract valuable information and provide insights into the business process, we collect and analyse data from a range of sources. To include data from the Survey of Income and Program Participation (SIPP) in our analysis, we use information from the following sources: - The Bureau of Labour Statistics (BLS) - The US Census Bureau - The National Bureau of Economic Research (NBER) Hundreds of characteristics were included in the first SIPP datasets. We used principal component analysis and other approaches to determine the top 10 criteria. Certain characteristics, such as the greatest level of schooling or employment, were unmistakably linked to various pay scales, whereas other characteristics, like gender, ethnicity, or health, had less of an impact. In order to arrive at a well-rounded





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strategy, we included both evident and subtle aspects. Using data mining tools to investigate these less obvious contributing elements is one of the key goals of this research project. We'll look more closely at the following characteristics, both fuzzy and not fuzzy:

Age Group: The age range (e.g., 25–54, 15–24, etc.) to which an individual belonged at the time of their most recent birthday;

The entire number of hours worked in a particular week, such as 27 hours, 36 hours, or 48 hours, is referred to as working hours;

- Education: The greatest degree of education a person has acquired, which might consist of:

- Bachelor's degree

- Master's degree

- PhD

- Some post-secondary education

- A secondary school certificate, or its equivalent

- Less than secondary school graduation

•Is Business Owner: This Boolean property specifies if a person owns a business or not;

•Lives in the City: - Residence Status: A person's place of residence, such as large urban centers (LUC) or rural and small town (RST) places, is indicated by this Boolean attribute.

•Employment Begin Year: The year when an individual began working.

•Marital Status: This attribute characterizes a person's kind of relationship, encompassing: Married or common law - Single or never married Divorced or separated; widowed

•Medical Condition: Any existing medical conditions, such as diabetes, that the person may have.

•Occupation: A person's job title (such as professor or student), which is converted to a salary scale using the BLS datasheet;

•Ethnic Ancestry: The ethnic background of an individual;

•Gender: An individual's gender, encompassing male, female, or gender non-conforming identities. This could or might not match the sex that was assigned to them at birth (male or female).

Cleaning Data

To determine a person's earning potential, low, moderate, and high incomes must be defined. It is common to use the phrase "middle class" loosely and without a defined meaning. The term "middle wage" in fuzzy logic describes values that fall roughly between the 25th and 75th percentiles of earnings for all jobs. As a result, the middle 50% of employees' compensation is considered to be in the medium wage range, while the bottom 25% are considered low wage and the top 25% are considered high wage.

There are two key benefits to this approach:

1. Rather of depending just on mean income, it eliminates bias from very high or low figures, giving a truer representation of the wages that most individuals get.
2. Because high and low incomes are less prevalent than middle earnings, it highlights them as more noteworthy during analysis. The monetary values for each fuzzified pay category, including hourly and annual wages, are shown in Table I.

The precise incomes of those polled are not disclosed in the SIPP statistics. It does, however, give their matching professions, which enables us to calculate their compensation based on the wages of others with comparable positions. For the purpose of determining the cut-offs for various salary categories, a BLS datasheet including information on numerous jobs and their corresponding pay was utilized. These criteria were applied while classifying occupations, along with the median salary. For instance, construction managers are classified as "high wage" workers since their average yearly compensation is almost \$91,370.

We categorised workers mostly according to their annual remuneration, unless hourly wages were the main unit of measurement. When the median values for comparable jobs—such as those of doctors and general practitioners—were not readily available, we calculated the median values using that information. We employed the BLS and SIPP





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data to classify professions as the employment categories in both sources are similar. The SIPP data has equivalent titles for all occupation codes in our data, and the BLS data includes classified jobs. Occupation titles were connected by shared traits. It is crucial to remember that an individual in a "middle wage" role might make more money than that category's median income, or they can be in a high or low pay range. However, median earnings within a profession offer a dependable estimate that reduces the impact of abnormally high or low pay rates. Entries in the SIPP dataset that did not have a specified occupation were filtered out. If the occupation field is empty, it might mean that the respondent either declined to disclose their occupation or did not answer the survey. It would be irrational to presume that these people were jobless. Furthermore, those who were below the legal working age were automatically removed from the dataset. The legal working age, or the minimum age at which a person can legally work, varies from country to country and even from state or province to province within a nation. For example, in the Canadian province of Manitoba, the legal working age for unrestricted labour is 18, according to the Worker Recruitment and Protection Act and the Employment Standards Code.

Classifying Data

We employ the default wage level groups of "low wage," "middle wage," and "high wage" for our study. Users can change these class labels, though, according on their tastes or the results of other clustering techniques, such as unsupervised learning. Both fuzzified and non-fuzzified attributes were used in Section III-A. Pay levels are anticipated to be impacted by a few of these traits. For example, since advanced degrees are frequently needed for high-paying positions, we expect that higher education levels will be associated with higher remuneration. Likewise, the variable Job Begin Year may hold considerable weight, given that persons who have just begun their careers may not possess the requisite experience for lucrative roles. On the other hand, working in lower-paying positions to obtain experience may be a prerequisite for moving up to higher-paid positions.

The BLS datasheet offers factual evidence in favor of the widely held notion that wages differ depending on the occupation. Furthermore, a person's working hours have a direct impact on their compensation. When someone is paid on an hourly basis, their overall earnings rise as more hours are put in. Due to the fact that large urban centers (LUC) often have greater work prospects than rural and small town (RST) locations, the variable Lives In City also has an impact. Politically, one should anticipate that individuals are treated equally regardless of age group, ethnic background, gender, marital status, and health state, among other criteria that shouldn't have a substantial influence on an individual's salary level. These traits could nevertheless, however, provide insightful information on useful social aspects. Our fuzzy logic-based C4.5 decision tree bases each choice on a certain measure that indicates how distinct each piece of data is from the others. Consequently, in dataset D, the qualities with the highest discriminative power are found closer to the root, while the traits with the lowest discriminative power are found closer to the leaves. We utilised entropy, a commonly utilised statistic in the field of data science, to assess variations in our study. Entropy = 0 in a homogeneous (pure) sample and one when the sample is divided evenly into two groups.

To calculate entropy, use the following formula:

$$\text{Entropy}(D) = - \sum_i p_i \log p_i$$

where p_i is D's class I ratio. Alternatively, similar measures such as the Gini index can be employed. By determining the reduction in entropy value that follows from a dataset split on an attribute A, we can compute the information gain, which helps estimate the amount of information acquired. Information gain may be calculated using the method below: where (D_j) , a subset of (D) , has a potential value for the characteristic (A) . The characteristic with the greatest information gain is selected at each decision tree node, and the attributes are categorised using this metric. The gain ratio is utilised to lessen bias towards qualities with several branches, while the split information reflects the knowledge gleaned from attributes not yet considered along the path from the root. These can be calculated using the following formulas:





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$$\text{GainRatio}(D, A) = \frac{\text{Gain}(D, A)}{\text{SplitInfo}(D, A)}$$

where

$$\text{SplitInfo}(D, A) = - \sum_j \frac{|D_j|}{|D|} \log_2 \left(\frac{|D_j|}{|D|} \right)$$

Improving Our Tool for Classification and Prediction

The tool described in Section III-C has been enhanced and expanded upon. As said, the decision tree is generated by the underlying technique using training data. The depth and branches of the decision tree are established using this training set. The training data is iteratively divided using the decision tree induction approach, starting at the root node, based on the impurity functions of the attributes, such as split info or gain ratio. The recursion ends when either no more characteristics are available for splitting, no more training data is available, or a node is pure (all of its data are from the same class). Put another way, if every piece of data for a certain node belongs to a single class (say, Age Division =25–54), the basic method will not produce any more child nodes or branches for other attribute values (say, Age Division =15–24, Age Division =55–64, Age Division =65–74, Age Division =75+). This is a result of the training data's lack of information for these variables. This "under-fitting" situation might cause issues when evaluating the classification and prediction model using test data that have varying values for those attributes (e.g., Age Group=15-24 to Age Group=75+).

In order to overcome this problem, we improve the baseline technique by producing all feasible branches, even in cases when the training data is incomplete. In particular, we construct child nodes for each attribute value that is contained in the training data, and then we utilize a majority vote derived from past classifications to allocate class labels to the attribute values that are not included in the training data. Adding to the previous example, we make branches for Age Division =25-54, Age Division =15-24, Age Division =55-64, Age Division =65-74, and Age Division =75+. As the training dataset grows, this approach helps address the issue that is mostly observed around the tree's leaves, where a major classification has already been made. Consequently, when we arrive at a node where specific child node information is not accessible, we use the frequency of classes in the data entries as a basis for classification. For example, if we arrive to the Age Division parent node with 10 data items and the majority of these values are categorized as "high wage," we classify all of Age Division child nodes as "high wage." As a result, when reaching the Age Division parent node, a test data item will either (a) continue ascending the tree in the event that Age Division =25-54, or (b) be categorized as "high wage" according to the current classification if it belongs to one of the other age groups.

Evaluation

We evaluated our technique with and without the branch extension update using two different datasets. The SIPP dataset was used to initially gather 35,981 data pieces. After screening, 12,000 submissions remained. We used 10,000 of these items as training data and the remaining 2,000 as testing data to construct the decision tree. Many runs were done in order to assess the performance.

A. Precision Initially, we used the following definitions to quantify sensitivity, accuracy, and precision

True Positives (TP): Examples of instances that were accurately classified as being at a certain pay grade.

True Negatives (TN): Cases when the attribute "not belonging to a specific pay level" was accurately predicted.

- False Positives (FP): Cases that are mistakenly identified as falling within a particular pay grade but are not in reality.

- False Negatives (FN): Cases that, although being wrongly projected to not belong to a certain pay level, do.

One way to calculate the sensitivity, or actual positive rate, is as follows:

Super sensitivity = $\frac{\{TP\}}{\{TP + FN\}}$ $\frac{\{TP\}}{\{TP + FP\}}$ is also known as Precision or positive predictive value (PPV).

Accuracy is computed using the following formula:

Accuracy = $\frac{\{TP + TN\}}{\{TP + TN + FP + FN\}}$



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The enhanced C4.5 decision tree-based tool we developed demonstrated a 10% increase in accuracy over the previous method.

Models of Classification and Prediction

The two basic and premium versions of our application employ a grouping approach that bases pay levels mostly on education. Due to the fact that many well-paying positions demand advanced degrees, this reflects the reality that more education often results in better incomes. Gender is next most important factor for those without a secondary school diploma. The next important factors for male employees are Age Group and Working Hours. The marital status of females lacking a secondary school diploma is an important consideration. Working Hours is the next crucial element for married women. Living in a city is more important to separated women than working hours. Job Begin Year comes in third for single women, and Working Hours comes in second for those with a secondary school diploma. The majority of people with a secondary school graduation earn "middle wages," although depending on their working hours, some may earn "low wages" or "high wages." Working Hours is the next important consideration for bachelor's degree holders, since they often earn more than those with merely a high school certificate. Master's degree holders normally make a lot more money, and PhD holders frequently make "high wages." The significance of leaf features in calculating wage levels is lower. Gender has less of an impact on highly educated people, but working hours are still crucial for all educational levels. In this regard, Age Group and Working Hours are more important than Gender and Is Business Owner.

DISCUSSIONS

In Section 3, we suggested an improved classification and prediction technique to solve the "under-fitting" problem in the initial iteration of our tool. In particular, the enhanced version creates sibling nodes and uses the majority vote from the available training data to assign these nodes the proper class labels. Adding more training data would improve our tool much more and solve the under-fitting issue. The terms "high wage," "middle wage," and "low wage" might have nebulous, subjective meanings. Due to varying cost of living, an income that is seen as "middle wage" in Georgia or Wyoming could be viewed as "low wage" in Massachusetts or New York. In a similar vein, a wage may be considered "high wage" in rural regions but "middle wage" in metropolitan areas. Fuzzy logic considers the inherent uncertainty to assist reduce these problems. Potential future developments for our fuzzy logic-based machine learning technology might include adding more implicit features that aren't listed in open databases. For instance, pay projections may take a high work ethic into account. We might improve our tool's accuracy and predictive power by adding more business-related components, such individual rewards for obedient and productive workers. These improvements have the potential to greatly increase our technology's efficiency in big data business analytics in intricate AI scenarios.

CONCLUSIONS

In this study, we presented a fuzzy logic-based machine learning framework that improves big data business analytics in intricate AI settings. In particular, we enhanced the conventional C4.5 technique by using fuzzy logic, producing a tool that facilitates the categorisation and forecasting of individual salary levels. This development makes resource allocation and addressing difficulties encountered by the disadvantaged easier for social analysts, public servants, and other stakeholders. Additionally, we enhanced the base version of the tool with branch extensions, which not only improved accuracy but also accelerated the mining and business analytics processes. Evaluations of both the basic and upgraded versions of our tool demonstrate its effectiveness and efficiency in predicting and classifying income levels. We want to keep improving our tool so that it can handle edge situations and outliers more effectively in the future. To improve the tool's capabilities, we also want to investigate other implicit and explicit elements impacting business processes in the corporate sector.





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Table I.: Fuzzified Wage Group

Fuzzy set	Pay scale	Salary per annum	Hourly pay
Min Val to 0.20	Low	< \$25770	< \$12.00
0.20 to 0.75	Middle	[\$25770, \$71110)	[\$12.00, \$30.00)
0.75 to maxVal	High	≥ \$71110	≥ \$30.00





Intelligent Path-Following Robot for Precision Farming

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ABSTRACT

This project aimed to design and develop an Arduino-based path-follower robot that can navigate through a predetermined path for precision farming using a set of sensors and control mechanisms. The robot was designed using a chassis, which consists of a base and two wheels, and a range of hardware components, including an Arduino UNO R3 microcontroller board, motor driver L293D, IR sensor module, and DC motors with wheels. Precision farming, a modern agricultural practice, leverages technology to enhance crops, yields and resource efficiency. One critical component of this approach is the deployment of intelligent robots capable of autonomously navigating agricultural fields with high precision. This paper presents the development of an intelligent path-following robot designed specifically for precision farming. The robot integrates advanced navigation algorithms, sensor fusion techniques, and machine learning to ensure accurate and efficient movement through crop rows. The logic used to control the robot involved the use of PID control, which adjusts the robot's speed and direction based on the sensor data received. The IR sensor module was used to detect the black line on the white surface, ensuring that the robot stays on track.. The PID algorithm was implemented using a combination of the IR and ultrasonic sensor data, which provided feedback to the controller for adjusting the motor speed and direction. The path-follower robot was tested by placing it on a predetermined path made of black lines on a white surface. The robot was able to follow the path without deviation and avoid any obstacles in the path. The robot's performance was evaluated by varying the speed of the robot and the complexity of the path. The robot was able to handle various path complexities and speed variations, making it suitable for use in different environments. Overall, the project was successful in achieving its objective of developing a robot that can navigate through a predetermined path using a set of sensors and control mechanisms, demonstrating the use of PID control for precise navigation.



Kuriti Jogi Naidu *et al.*,**Keywords:** IR sensor, Arduino Nano, L293D motor, proportional Integral Derivative.

INTRODUCTION

Robots have become an integral part of modern society, with various applications in industries such as manufacturing, healthcare, transportation, and many more. Robotics education has gained popularity in recent years, with many institutions offering courses and programs to equip students with the necessary skills to design and develop robots. The Arduino-based path-follower robot project is a practical project designed to provide students with hands-on experience in designing and developing a robot using an Arduino Nano microcontroller board [1]. The project involves designing and developing a path-follower robot that can accurately follow a pre-determined path using an IR sensor module and control mechanisms [2]. The project's main objective is to develop a robot that can navigate through a path while maintaining a consistent speed, which has practical applications in various farming techniques. The project provides an opportunity for students to learn the basics of robotics, including the hardware design, programming, and control mechanisms required to develop a functional robot. The use of an Arduino Nano microcontroller board provides an accessible platform for students to develop their skills in robotics education. The project also provides an opportunity for students to learn about the practical applications of robotics in various industries [3]. The use of an Arduino Nano microcontroller board as the The use of a PID algorithm in the robot's control mechanism provides precise control over the robot's speed and direction, ensuring that the robot can accurately follow the predetermined path [5].

METHODOLOGY

The Arduino-based path-follower robot project involves the development of a robot that can accurately follow a pre-determined path using an IR sensor module and control mechanisms. The following are the steps involved in developing the path-follower robot prototype for a college project [6].

Hardware design: The first step in developing the robot prototype is designing the hardware components. The hardware components required for the project include an Arduino Nano microcontroller board, motor driver, DC motors, IR sensor module, chassis, wheels, and power source. The chassis and wheels are assembled, and the Arduino Nano board, motor driver, and IR sensor module are mounted on the chassis [7].

Programming: The next step is programming the Arduino Nano board to control the robot's movement and navigate through the pre-determined path. The programming code involves setting up the IR sensor module and motor driver, implementing the PID algorithm for speed and direction control, and defining the robot's movement along the path [8].

Testing: After programming the robot, the next step is testing the robot's movement and control mechanisms. The robot is tested on a pre-determined path to ensure that it can accurately follow the path, avoid obstacles, and maintain a consistent speed.

Final testing: The final step is to test the refined robot prototype to ensure that it can accurately follow the predetermined path and navigate through obstacles. The robot's movement, accuracy, and speed are tested to ensure that it meets the project requirements [9].

Working

PID Control Mechanism: The PID control mechanism is used to control the robot's speed and direction. The control mechanism receives input from the IR sensor module, which provides information about the position of the path. The control mechanism then uses the PID algorithm to adjust the speed and direction of the robot's movement to ensure that it stays on the path [10].

Motor Driver: The motor driver is used to control the DC motors' speed and direction, which are responsible for the robot's movement. The motor driver receives input from the PID control mechanism and adjusts the motor's speed and direction accordingly.



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Power Source: The power source is used to provide the necessary power for the Arduino Nano board, motor driver, and DC motors. The power source is typically a rechargeable battery that provides the necessary voltage and current to power the robot.

Programming Code: The programming code for the Arduino Nano board controls the robot's movement and navigation through the path. The code includes setting up the IR sensor module and motor driver, implementing the PID algorithm for speed and direction control, and defining the robot's movement along the path [11].

Component Specification

Arduino Nano:

IC 7805:

Capacitor:

Resistor

L293D pin configuration:

IR sensor:

L293D motor driver: The L293D is a 16 pin IC with 8 pins on each side dedicated to motor control. Each motor has two INPUT pins, two OUTPUT pins, and one ENABLE pin as shown in figure-7. The L293D consists of two H-bridges. An H-bridge is the simplest circuit to control a low current motor. Here is a theory of how the H-bridge works. An H-bridge can be modeled as four switches at the corners of an "H", hence the name. Here is a basic diagram of an H-bridge in figure-2:

RESULTS

The result given below Figure 3 and 4

Circuit Diagram

The circuit diagram below Figure 5

Advantages

Cost-effective: The project is cost-effective and can be built using readily available and inexpensive components, such as IR sensors, motors, and an Arduino Nano board.

Easy to assemble: The project is easy to assemble and can be built by individuals with basic knowledge of electronics and programming.

Customizable: The project can be customized to fit specific requirements and applications, such as changing the robot's speed, orientation, and path following algorithm.

Disadvantages

Limited terrain adaptability: The robot may face difficulty in navigating through terrain that is uneven or has obstacles that are difficult to detect with IR sensors.

Applications

Manufacturing: Path-follower robots can be used in manufacturing industries to transport goods from one place to another, without human intervention. They can also be used for quality control, inspection, and testing.

Agriculture: Path-follower robots can be used in agriculture to automate tasks such as crop monitoring, spraying, and harvesting. They can also be used for soil analysis and data collection¹⁴.

Logistics: Path-follower robots can be used in logistics to transport goods within a warehouse or distribution center. They can also be used for inventory management and tracking.

Surveillance: Path-follower robots can be used for surveillance purposes, such as monitoring a specific area for security or safety purposes.





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Education and research: The path-follower robot project can be used for educational purposes in robotics and programming. It can also be used for research purposes in autonomous robot navigation, control, and optimization¹⁵.

CONCLUSION

In conclusion, The Arduino-based path-follower robot project serves as a stepping stone towards developing more complex and advanced robotics systems, with the potential to revolutionize various industries and research fields. Our path following robot is designed to revolutionize precision farming by providing accurate and efficient navigation through your fields. Equipped with advanced sensors and GPS technology, this robot can follow predetermined paths with precision, reducing waste and improving crop yields. Whether it's planting, spraying, or monitoring, our robot is designed to streamline your farming operations and help you make data-driven decisions

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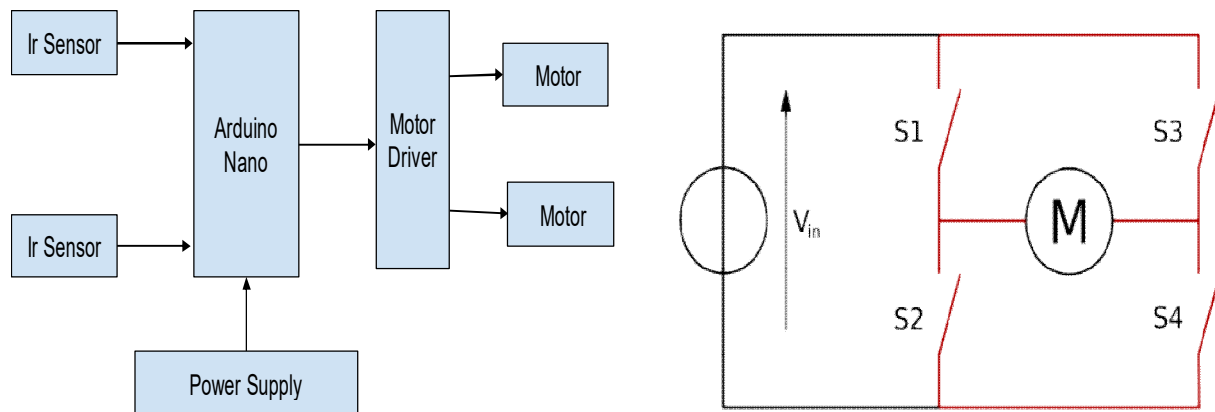
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Figure.1 Block diagram of autonomous path following robot Figure 2: L293D motor driver circuit



Figure 3,4 : Result

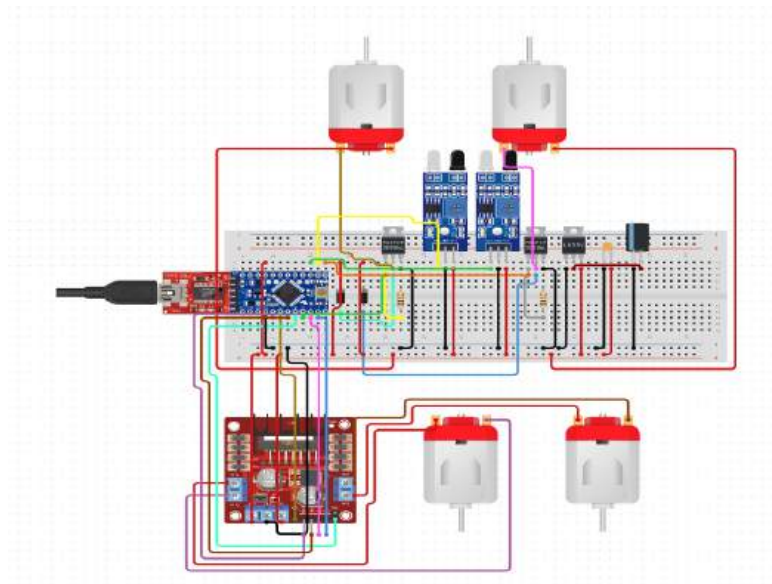
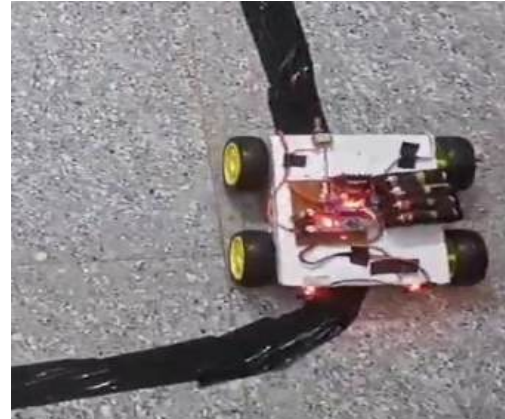


Figure 5 Circuit Diagram





RESEARCH ARTICLE

Evaluation of Carotid Artery Stenosis Under MRI & Doppler Ultrasound

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ABSTRACT

The disorder known as carotid artery stenosis causes the main artery on either side of the neck, the carotid artery, to become clogged. The plaque like substance, which is made up of fatty cholesterol deposits, cause the obstruction. The internal carotid artery (ICA) and the external carotid artery (ECA), which provide blood to the neck, thyroid gland, face, and scalp respectively, are where the plaque typically develops. When the brain is deprived of oxygen due to a stroke, brain cells start to degenerate within minutes. Transient ischemic attack (TIA), or stroke, is caused by a steady buildup of plaque in the arteries, which causes a brief reduction in blood supply to the brain. Normal, healthy arteries are elastic and have smooth inner walls, but as people age, their blood pressure rises, and they sustain minor wounds to their blood vessel walls, plaque can begin to form. A big mass of sticky material called plaque that accumulates over time inside the inner wall of an artery and narrows its lumen (internal diameter) is formed of fat, cholesterol, calcium, and other fibrous materials. The range of moderate arterial narrowing from 15% to 49% is related to a number of variables, including diabetes and smoking, and over time, this narrowing can worsen and result in stroke. A non invasive examination called carotid Doppler or duplex ultrasonography can measure how small an artery is, quantify blood flow fluctuations, and assess carotid stenosis suspicion. Patients may feel claustrophobic during an MRI despite the fact that it is a non-invasive procedure and images are stitched together by a computer to show an image of an arteries in the head and neck where contrast material is required.

Keywords: Carotid artery occlusion, Doppler carotid, MRA, CT Neck Angio, Atherosclerosis





INTRODUCTION

A condition known as carotid artery stenosis occurs when the big artery on either side of the neck, the carotid artery, becomes clogged. The 5% of people with CAS of 70% or higher will experience a stroke within 5 years. Over 6,00,000 American adults will experience an ischemic stroke due to CAS per year. Because it is a risk factor for ischemic stroke, Carotid artery stenosis (CAS), an atherosclerotic constriction of the extracranial carotid arteries, is clinically significant[1]. The distinction between an embolic and hemodynamic stroke depends on the presence of persistent internal carotid artery blockage. Cervical carotid disorders are linked to one-third of all strokes and patients with symptoms such limb shaking, retinal claudication, headache from a significant pulsatile external carotid artery collateral, syncope, and nonspecific weariness. Retinal claudication, also known as amaurosis fugax, is a condition where vision loss lasts for a brief period of time. Retinal claudication may be brought on by hyperglycemia conditions, such as those that occur in pregnant women, or it may be brought on by an ischemic condition, which happens when there may be a blockage in the carotid artery. Ophthalmic artery is one of the branches of the carotid artery which supplies the blood to the eye ball. When there is a blockage/ atherosclerosis of the carotid artery, blood flow to the eye decreases, which makes the person lose the vision for the short period of time, What is supposed to be noted here is that why the vision loss is happening for a short period of time and when does this occur [1, 2,5]. Checklists allow us to accomplish repetitious chores more quickly. A checklist offers people a sense of security and accountability. Positive health outcomes using checklists include fewer complications, injuries, deaths, and other patient damage.

Let's understand, when their excess amount of light shined in front of the eye ball the photoreceptor starts working with full potential, that is phototransduction happens with a greater potential, which indeed triggers the need for the more blood, As there is blockage in the carotid artery, the sufficient amount of the blood cannot be supplied by the ophthalmic artery which results in the transient vision loss. Once the light is turned off after the recovery phase, the person gets back the normal vision what he or she has. Vision loss in the right eye indicate that the blockage is present on ipsilateral side that is in right carotid artery and vice-versa. Because of this, retinal claudication is regarded as one of the key symptoms to recognize Carotid artery blockage and aids in the prevention of CAD. Increased carotid artery stenosis raises the risks of embolization and hemodynamic compromise, and the carotid bifurcation plaque is typically the mechanism of cervical carotid stroke. However, hemodynamic compromise from stenosis may also be involved. Every year, in the over-65 population, 5-10% of persons have proximal carotid artery stenosis with a stenosis more than 50%, and 0.3-2.0% of patients with asymptomatic carotid artery stenosis get an ischemic stroke. Carotid artery stenosis is one of the leading causes of stroke. The mechanisms of stroke or transient ischemic attack in proximal carotid stenosis are artery to artery embolism from an unstable plaque or hypo perfusion due to severe stenosis with weak collaterals. About 15% of individuals with ACAS have warning signals prior to an ischemic stroke.

The carotid arteries can be evaluated quickly and non-invasively using ultrasound, and technological advancements in sonographic equipment, improvements in operator skill, and accreditation bodies have all helped to raise the standard of carotid sonographic evaluation. The carotid bifurcation can be seen in 3-D utilizing MRI, which has good sensitivity for detecting high-grade carotid artery stenosis. The MRA approach can identify carotid artery occlusion or severe stenosis in 91% to 99% of cases. Conventional MRI techniques can be used to analyze the composition and shape of carotid atherosclerotic plaques. By using MRI, different phases of atherosclerotic lesions can be identified and characterized.

Carotid arteries have three layers.

1. Intima: An innermost layer that is smooth and helps easy blood flow.
2. Media: A fibrous middle layer that aids in regulating the artery's diameter.
3. The adventitia is the artery's outermost layer of protection.



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AIM AND OBJECTIVES

AIM-Evaluation of carotid artery stenosis under mri & doppler ultrasound.

OBJECTIVES

- To evaluate stenosis of carotid artery.
- To find out whether the stenosis is more prevalent in males or females and under which age groups.
- To evaluate carotid artery stenosis by using MRI & doppler ultrasound as a equipment.

METHODS AND MATERIALS

Source of data

Patients, who came into the Radiology Department of Apollo Hospitals for Radiological examination.

Study duration

This study was carried out over a period of 6 months in Department of Radiology, Apollo Hospital, Hyderabad.

Study design

This study will be an Observational study. In which we collect total 51 patients both Males and Females .

Study area:

Department of Radiology, Apollo Hospital, Hyderabad.

Inclusion Criteria

- Patients with age of between 20-80 years were selected.
- Patients having different diseases such as carotid stenosis, Blockage.

Exclusion Criteria

- Patient Refusal.
- Normal Patients.
- Patients with pacemakers.
- Age below 20 years and above 80 years.

RESULT

Plaque Classification under Doppler

CLASS I: Homogenous texture and uniformly hypoechoic.

CLASS II: Heterogeneous texture and predominantly hyperechoic.

CLASS III: Heterogeneous texture and predominantly hyperechoic.

CLASS IV: Homogeneous texture, uniformly hyperechoic.

CLASS V: Unclassified calcified plaque.

Observation

In total, 35 male and 16 female were registered in this study. Data from the Doppler ultrasound assessment and MRI pictures were acquired. One patient (0f) in the study group had a diagnosis of a right external carotid artery with a lower degree of stenosis. Individuals who had both diabetes mellitus and hypertension were considered high-risk; of the 51 patients, 31 had hypertension, and 36 had diabetes. Severity analysis revealed that, of the 51 patients, 34 had mild stenosis (67%), 11 had moderate stenosis (21%), and 6 had severe stenosis (12%). More than half of those who receive no treatment at all within 6 to 12 weeks report significant symptom alleviation. Patients who are obese are more likely to have plaque accumulation in their blood vessels. Plaque in blood arteries causes them to narrow and



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stop supplying blood to the brain, which can result in stroke. Based on research, we discovered that patients are more affected by the type of plaque that forms in the common carotid artery. Patients between the ages of 71 and 80 have a higher risk of developing carotid artery stenosis.

DISCUSSION

As one of the main causes of acute ischemic stroke, the common carotid artery can be categorized as symptomatic or asymptomatic. Because carotid endarterectomy is well-supported in reducing the overall risk of recurrent stroke, it is still a crucial part of the treatment for carotid artery stenosis. The development of atherosclerotic plaque in the internal carotid artery occurs in both the neck and the skull. When it comes to atherosclerosis, which is a chronic arterial disease caused by the buildup of cholesterol, fat, and calcium in the artery walls, patients usually have one or more prior TLAs before suffering a stroke

CONCLUSION

One of the main causes of acute ischemic stroke is coronary artery stenosis, which can be categorized as either a symptomatic or asymptomatic condition depending on whether the condition is correlated with a stroke or transient ischemic attack. When the degree of stenosis is less than 80%, patients with asymptomatic CAS should be treated with BMT and referred to a vascular surgical program. Patients with symptomatic CAS should start antiplatelet medication and be evaluated for surgery. CEA is the gold standard for the surgical care of symptomatic CAS and should ideally be performed within two weeks of the initial occurrence. Its goal is to lower the risk of recurrent strokes without affecting the result of the initial stroke. A study indicates that the external carotid artery is less prone to develop stenosis than the common carotid artery. These studies demonstrate that stenosis can be caused by aging, obesity, and a lack of activity. The incidence of stenosis increases with age and decreases with younger age. In summary, obesity, lifestyle, inactivity, and unhealthy eating habits all contribute significantly to the development of stenosis in blood arteries. Therefore, it's critical to maintain healthy eating habits and exercise routines in order to avoid developing carotid artery stenosis.

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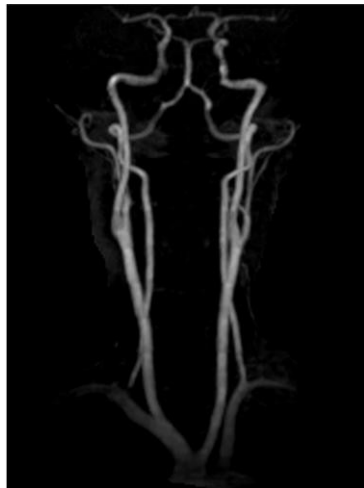
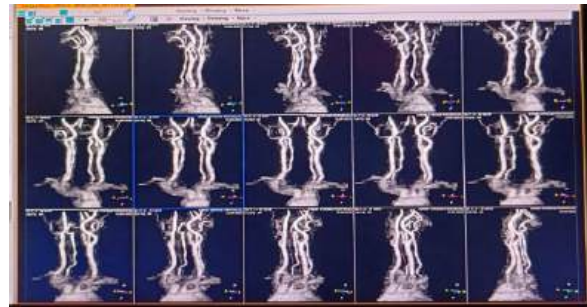
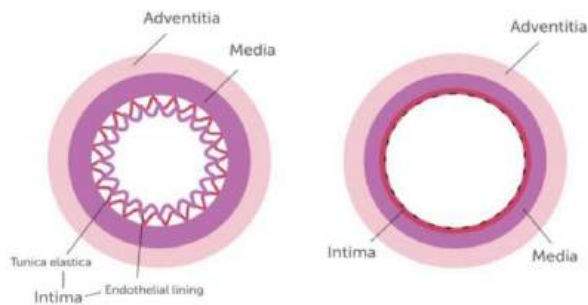
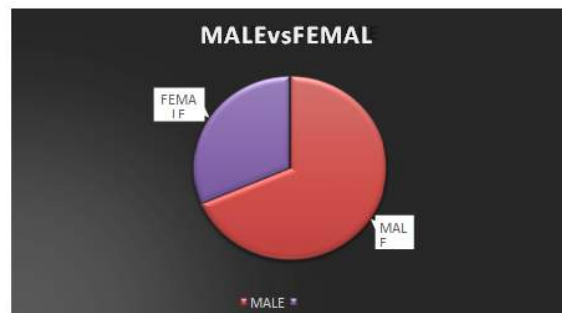
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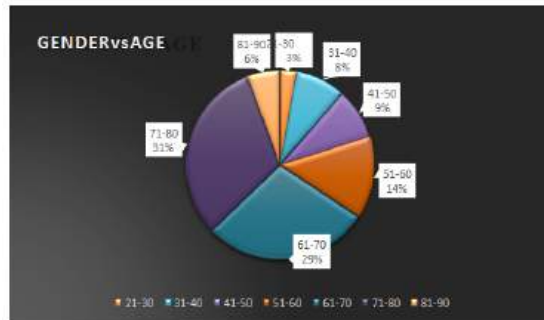
Table 1 Doppler Criteria for Ica Stenosis Detection Under doppler

STENOSIS	ICAPSVcm/s	PLAQUE/DIAMETER
Normal	<125	None
<50%	<125	<50%
50%-69%	125-230	>50%
>70%tonearocclusion	>230	>50%
Nearocclusion	High,low, orundetactable	Visible
Occlusion	Undetectable	Visible,no detectablelumen.

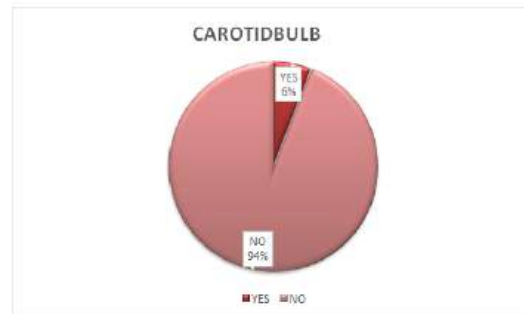
Table 2. Carotid Stenosis Criteria Under Doppler

Stenosis	Peak systolic velocity(cm/s)	Peak end diastolic velocity(cm/s)	Peak systolic velocity Ratio
<50	<150	<50	<2.0
50-59	150-200	50-60	2.0-2.5
60-69	200-250	60-70	2.5-3.0
70-79	250-325	70-90	3.0-3.5
80-89	325-400	70-100	3.5-4.0
90-99	>400	>100	>4.0
Occlusion	Notapplicable	Notapplicable	Notapplicable

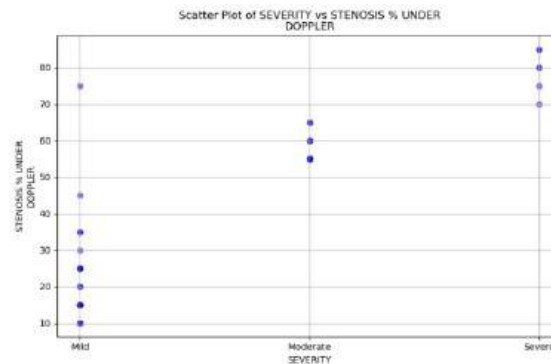
**Fig1.Carotidarteries****Fig .2.Carotid arteries have three layers.****Fig .3.outermost layer of protection****Pie Chart 2.1 –Data Representing Male Vs Female**



Pie Chart 2.2 –Data Representing Age vs Gender



PieChart2.7–Data Representing% of Patients Vs Carotid bulb



Bar Graph 1. 11 –Data Representing No.of Patients vs Severity





Influence of Power Loss in Matched Terminations on the Design of Slot Coupled Wave Guide Junctions

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ABSTRACT

Slot-coupled waveguide junctions often produce desired polarized radiated fields. The array of such junctions can be used to generate specified radiation patterns if they are optimally designed. This depends on several parameters; however, an attempt is made to investigate the influence of power loss in matched terminations on designing an array of such junctions. A cascade of junctions is replaced by its equivalent circuit, where each junction represents a shunt element of admittance. When the second port of the feed guide is connected to a matched termination, 5 to 15% power is dissipated in the termination, as no termination is ideal. The terminations assume power loss for a typical Taylor amplitude distribution. The desired conductance values of each junction are numerically computed. From such data, slot parameters are evaluated in the present work. The results show that power loss in termination significantly affects the design of slotted junctions.

Keywords: Slot coupled, waveguide, junction, parameters, termination

INTRODUCTION

Waveguide slot radiators are popular due to their compactness [1-4]. The slots are cut either in the broad wall or in the narrow wall of the rectangular waveguide for the sake of controlled radiation. The vertical slots in the narrow





wall do not radiate as the field lines. Such slots are, therefore, not useful for radiation, but they are useful for field/impedance measurements. In view of the above facts, inclined slots are fabricated to produce horizontally polarized fields, but the inclined slots generate cross-polarized fields, which are not desirable as they create Electro Magnetic Interference (EMI) problems in radar receivers [5]. To mitigate such EMI problems, a coupling Waveguide is flushed with the feed Waveguide so that the slot radiates into the coupled Waveguide. The coupled Waveguide forms a TM, which in turn radiates power into free space. The orientation of the TM decides the type of polarization. The resultant radiation will be either horizontal or vertical. The array of such structures is required for applications where the user demands polarization purity. The design or analysis of such arrays is very complex and highly involved. However, investigations are carried out in the present work to bring out the influence of the power loss in the matched terminations of the arrays. For the purpose of analysis, a tapered power distribution [fig 4] for the radiating elements of the array is considered. It is well known that the tapered distributions yield low side-lobe radiation patterns [6]. A narrow beam antenna uses an array of matched waveguide radiators, each element of which is excited by a Tee junction. The antenna design consists of a primary guide feeding the cascaded sections of such junctions. The aperture distribution for a sidelobe level equal to -28dB and $\bar{n}$ equal to 5 is first obtained using Taylor's [7] formulation. The computed data is used to find the sampled values of the normalized powers delivered to the successive junctions satisfying the power balance condition. The equation for the power balance condition contains the fraction of the input power delivered to the load as a parameter. The resonant conductance yielding the desired amplitude distributions is found using the power balance equation and recursive formulation developed by Yevstropov and Tsarapkin [8]. This formulation is based on the transmission matrix approach. The method considers all interactions between the junctions for the propagating wave in the primary guide. Successive application of the transmission matrix starting from the last junction leads to synthesizing the desired aperture distribution.

ANALYSIS

An array of waveguide junctions is shown in figure 1

Its equivalent circuit is given by [1]

Consider an equivalent circuit of the waveguide junction's radiator in Fig 3.

For the configuration shown above, the transition matrix [8-9]

$$\begin{bmatrix} I_{XY} \\ R_{XY} \end{bmatrix} = \begin{bmatrix} T_{11}^X & T_{12}^X \\ T_{21}^X & T_{22}^X \end{bmatrix} \begin{bmatrix} I_X \\ R_X \end{bmatrix}$$

Here

$$T_{11}^X = (1 + Y_s/2)e^{j\theta_d}$$

$$T_{12}^X = (Y_s/2)e^{j\theta_d}$$

$$T_{21}^X = (-Y_s/2)e^{-j\theta_d}$$

$$T_{22}^X = (1 - Y_s/2)e^{-j\theta_d}$$

$$\theta_d = \text{Electrical spacing between elements} = \frac{2\pi}{\lambda_g}d + \pi$$

λ_g = Guide wavelength

d = spacing.

If P_n is normalized power delivered to the n^{th} junction,

$$\text{We have } \sum_{n=1}^N (P_n + \Delta) = 1$$

Here

Δ is fractional power loss in matched termination.

N = no. of junctions in the array

For matched termination,

$R_N = 0$ and the amplitude of incident wave I_N is used as a reference.

If the normalized power is unity,

We have

$$\Delta = I_N^2 \cdot 1$$





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Then

$$g_n = \frac{P_N}{I_N^2} = \frac{P_N}{\Delta}$$

And

$$g_{n-1} = \frac{P_{N-1}}{[I_{N-1} + R_{N-1}]^2}$$

Operating at resonance with inter element spacing at $\lambda_g/2$

We get

$$g_n = \frac{P_N}{\sum_{m=1}^N P_m} \left[\frac{1-\Delta}{\Delta} \right]$$

Here, g_n gives the conductance of the n^{th} junction.

RESULTS

For a power distribution to the array shown in fig 4

$$\Delta = 0.05$$

$$\Delta = 0.10$$

$$\Delta = 0.15$$

The narrow dimension of the primary waveguide is 1.52cm, with a broad dimension of 2.286cm. The required conductances are numerically computed and presented for $N=50$ elements in Table 1-3

CONCLUSION

It is found from the results presented that the power dissipated in the termination has a lot of effect on the conductance loading of each element. The power distribution is symmetric, and hence, conductance loading is also symmetric.

The conductance g_n was found to vary between 0.02763 & 0.3645 for $\Delta = 0.1$.

For $\Delta = 0.05$ g_n varies between 0.05833 & 0.7696 and

For $\Delta = 0.15$, g_n is found to vary between 0.0174 & 0.22955.

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Table-I for $\Delta = 0.05$

Radiator number	Radiator power levels	Computed conductance values	Designed inclinations	Designed slot lengths
1	0.07578	0.05833	17.90	15.190
2	0.07935	0.06108	18.35	15.185
3	0.08671	0.06674	19.20	15.180
4	0.09827	0.07564	20.20	15.180
5	0.11460	0.08820	21.65	15.180
6	0.13632	0.10492	23.40	15.184
7	0.16402	0.12624	25.10	15.208
8	0.19810	0.15247	28.25	15.275
9	0.23869	0.18371	30.25	15.340
10	0.28553	0.21976	33.25	15.465
11	0.33794	0.26010	35.75	15.485
12	0.39489	0.30390	38.00	15.680
13	0.45510	0.35027	40.00	15.814
14	0.51716	0.39804	42.25	15.930
15	0.57971	0.44618	44.50	16.050
16	0.64152	0.49375	45.50	16.100
17	0.70150	0.53992	47.25	16.185
18	0.75872	0.58396	48.25	16.220
19	0.81227	0.62517	49.25	16.260
20	0.86123	0.66285	50.20	16.280
21	0.90458	0.69622	51.25	16.300
22	0.94121	0.72441	51.50	16.305
23	0.96998	0.74656	52.00	16.315
24	0.98985	0.76185	52.25	16.324
25	1.00000	0.76966	52.75	16.325
26	1.00000	0.76966	52.75	16.325
27	0.98985	0.76185	52.25	16.324
28	0.96998	0.74656	52.00	16.315
29	0.94121	0.72441	52.50	16.305
30	0.90458	0.69622	51.25	16.300
31	0.86123	0.66286	50.20	16.280
32	0.81227	0.62518	49.25	16.260
33	0.75872	0.58396	48.25	16.220
34	0.70150	0.53992	47.25	16.185
35	0.64152	0.49375	45.50	16.100
36	0.57971	0.44618	44.50	16.050
37	0.51716	0.39804	42.25	15.930
38	0.45510	0.35027	40.00	15.814
39	0.39489	0.30393	38.00	15.680
40	0.33794	0.26010	35.75	15.485
41	0.28553	0.21976	33.25	15.465
42	0.23869	0.18371	30.25	15.340
43	0.19810	0.15247	28.25	15.275
44	0.16402	0.12624	25.10	15.208
45	0.13632	0.10492	23.40	15.184





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46	0.11460	0.08821	21.65	15.180
47	0.09827	0.07564	20.20	15.180
48	0.08671	0.06674	19.20	15.180
49	0.07935	0.06108	18.35	15.185
50	0.07578	0.05833	17.90	15.190

Table-II for $\Delta = 0.1$

Radiator number	Radiator power levels	Computed conductance values	Designed inclinations	Designed slot lengths
1	0.07578	0.02763	12.30	15.230
2	0.07935	0.02893	12.90	15.229
3	0.08671	0.03161	13.30	15.225
4	0.09827	0.03583	14.20	15.219
5	0.11460	0.04178	15.10	15.200
6	0.13632	0.04970	16.60	15.192
7	0.16402	0.05980	18.20	15.190
8	0.19810	0.07222	19.70	15.180
9	0.23869	0.08702	21.60	15.183
10	0.28553	0.10410	23.40	15.182
11	0.33794	0.12320	25.10	15.204
12	0.39489	0.14397	27.50	15.250
13	0.45510	0.16592	28.75	15.285
14	0.51716	0.18854	31.00	15.375
15	0.57971	0.21135	32.50	15.432
16	0.64152	0.23388	34.25	15.509
17	0.70150	0.25575	35.25	15.558
18	0.75872	0.27661	36.25	15.605
19	0.81227	0.29613	38.00	15.685
20	0.86123	0.31398	39.50	15.705
21	0.90458	0.32979	39.00	15.730
22	0.94121	0.34314	39.75	15.770
23	0.96998	0.35363	40.00	15.814
24	0.98985	0.36088	40.50	15.832
25	1.00000	0.36458	40.75	15.850
26	1.00000	0.36458	40.75	15.850
27	0.98985	0.36088	40.50	15.832
28	0.96998	0.35363	40.00	15.814
29	0.94121	0.34314	39.75	15.770
30	0.90458	0.32979	39.00	15.730
31	0.86123	0.31399	38.50	15.705
32	0.81227	0.29614	38.00	15.685
33	0.75872	0.27661	36.25	15.605
34	0.70150	0.25575	35.25	15.558
35	0.64152	0.23388	34.25	15.509
36	0.57971	0.21135	32.50	15.432
37	0.51716	0.18854	31.00	15.375
38	0.45510	0.16592	28.75	15.285
39	0.39489	0.14397	27.50	15.250





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40	0.33794	0.12321	25.10	15.204
41	0.28553	0.10410	23.40	15.182
42	0.23869	0.08702	21.60	15.183
43	0.19810	0.07222	19.70	15.180
44	0.16402	0.05980	18.20	15.190
45	0.13632	0.04970	16.60	15.200
46	0.11460	0.04178	15.10	15.200
47	0.09827	0.03583	14.25	15.219
48	0.08671	0.03161	13.30	15.225
49	0.07935	0.02893	12.90	15.229
50	0.07578	0.02763	12.30	15.230

Table-III for $\Delta = 0.15$

Radiator number	Radiator power levels	Computed conductance values	Designed inclinations	Designed slot lengths
1	0.07578	0.01740	9.80	15.240
2	0.07935	0.01822	10.00	15.239
3	0.08671	0.01990	10.50	15.239
4	0.09827	0.02256	11.20	15.235
5	0.11460	0.02631	12.00	15.230
6	0.13632	0.03129	13.20	15.225
7	0.16402	0.03765	14.30	15.215
8	0.19810	0.04547	15.80	15.200
9	0.23869	0.05479	17.30	15.190
10	0.28553	0.06554	18.90	15.180
11	0.33794	0.07757	20.30	15.180
12	0.39489	0.09065	21.90	15.180
13	0.45510	0.10447	23.40	15.185
14	0.51716	0.11871	24.80	15.200
15	0.57971	0.13307	26.25	15.225
16	0.64152	0.14726	28.25	15.268
17	0.70150	0.16103	29.50	15.315
18	0.75872	0.17416	30.00	15.335
19	0.81227	0.18646	30.75	15.360
20	0.86123	0.19769	31.50	15.395
21	0.90458	0.20765	32.50	15.432
22	0.94121	0.21605	33.00	15.455
23	0.96998	0.22266	33.25	15.468
24	0.98985	0.22722	33.50	15.480
25	1.00000	0.22955	33.75	15.487
26	1.00000	0.22955	33.75	15.487
27	0.98985	0.22722	33.50	15.480
28	0.96998	0.22266	33.25	15.486
29	0.94121	0.21605	33.00	15.455
30	0.90458	0.20765	32.50	15.432
31	0.86123	0.19769	31.50	15.395
32	0.81227	0.18646	30.75	15.360
33	0.75872	0.17416	30.00	15.335

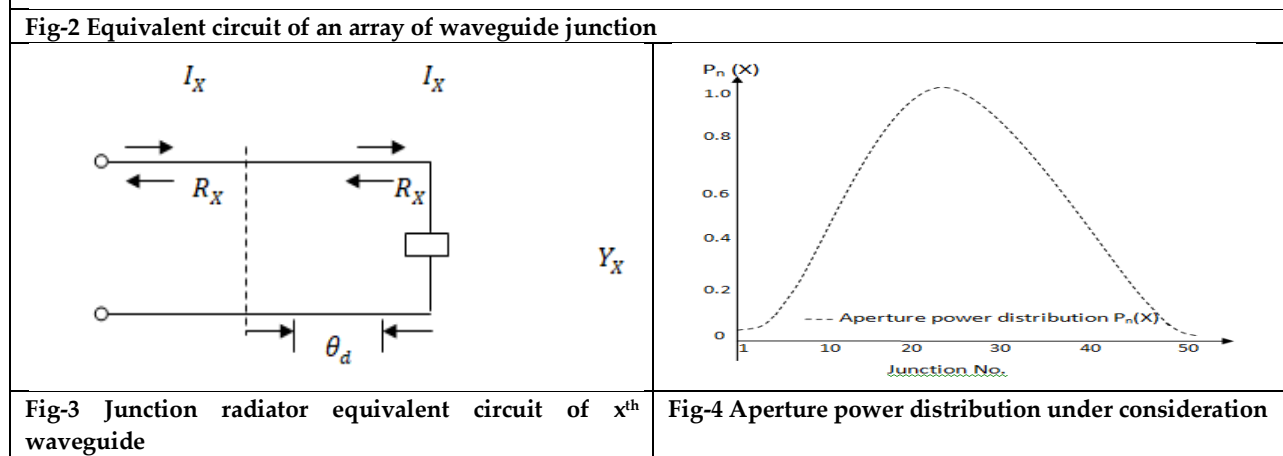
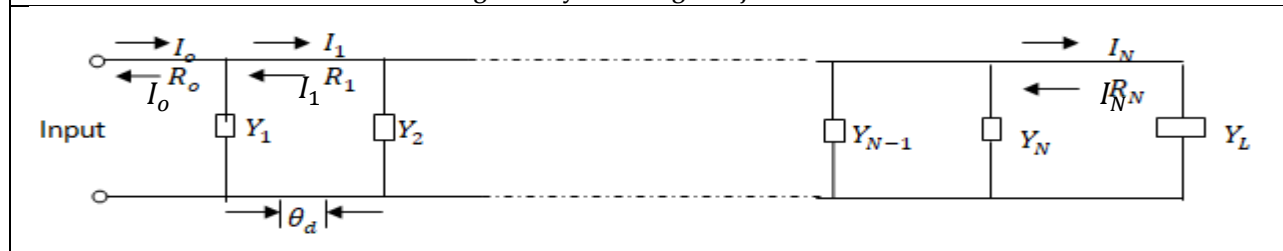
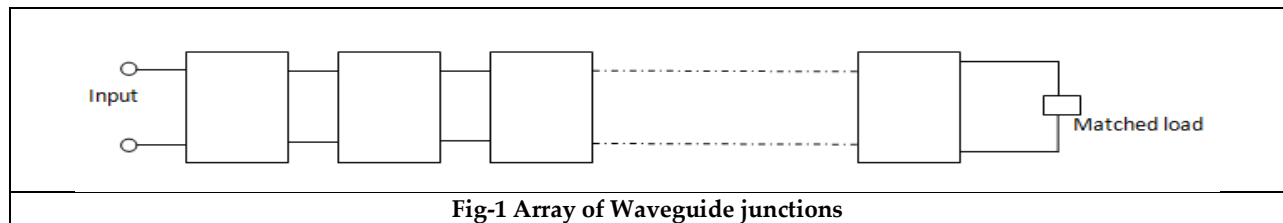




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34	0.70150	0.16103	29.50	15.315
35	0.64152	0.14726	28.25	15.268
36	0.57971	0.13307	26.25	15.225
37	0.51716	0.11871	24.80	15.200
38	0.45510	0.10447	23.80	15.185
39	0.39489	0.09065	21.90	15.180
40	0.33794	0.07757	20.30	15.180
41	0.28553	0.06554	18.90	15.180
42	0.23869	0.05479	17.30	15.190
43	0.19810	0.04547	15.80	15.200
44	0.16402	0.03765	14.30	15.215
45	0.13632	0.03129	13.20	15.225
46	0.11460	0.02631	12.00	15.330
47	0.09827	0.02256	11.20	15.235
48	0.08671	0.01990	10.50	15.239
49	0.07935	0.01822	10.00	15.239
50	0.07578	0.01740	9.80	15.240

The values of g_n determined the slot parameters like slot length & slot inclination, keeping slot width constant.





ZnO NPs Assisted One Pot Synthesis of Hexahydroquinazolinone / Thione Derivatives

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ABSTRACT

Zinc Oxide nanoparticles serve as a highly efficient heterogeneous catalyst for several organic reactions. A multitude of scientists have invested considerable efforts in utilizing nanoZnO as a sustainable catalyst for the synthesis of N- and O-containing heterocyclic compounds. Nano Zinc Oxide was identified as a highly efficient, environmentally friendly, and recyclable heterogeneous catalyst for the synthesis of Hexa hydro quinazolinone / thione Derivatives via a one-pot three-component reaction involving substituted Aromatic aldehyde, urea/thiourea, cyclohexanone at 80°C, utilizing ethyl alcohol as the solvent.

Keywords: Hexa hydro quinazolinone /thione, Nano Zinc Oxide, Aromatic aldehyde, urea/thiourea, cyclohexanone

INTRODUCTION

Multi-component reactions (MCRs) have a significant role in chemical synthesis. Multi-component reactions (MCRs) contain three or more simple substrates in a single reaction vessel, resulting in molecular complexity that incorporates significant constituents from all reactants. MCRs have shown to be a valuable tool in organic and



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medicinal chemistry due to their utility in the synthesis of multifunctional and structurally varied drug-like compounds. MCRs have emerged as an effective synthetic technique owing to their atom economy, straightforward methodology, and convergent characteristics. Its significance primarily lies in synthesis, including pharmaceuticals, natural goods, and biodegradable plastics, hence playing a crucial role in both convergent and conventional synthesis [1-6]. The advancement of efficient, environmentally sustainable technology for the swift synthesis of potentially beneficial molecules has become a primary objective for researchers in organic synthesis. The creation of carbon-carbon bonds is essential in organic molecules, including pharmaceuticals, biodegradable polymers, and natural products, and extensive research has been dedicated to this field. Heterogeneous catalysis is typically favored over homogeneous catalysis in numerous industrial applications and fundamental research due to its straightforward workup, reusability, and ease of handling. Considering economic and environmental factors, there is a continuous initiative to substitute traditional catalysts with solid heterogeneous catalysts, mostly due to advantages such as non-toxicity, cost-effectiveness, non-corrosiveness, and ease of recovery and reuse. Surface-active metal oxides are typically employed to synthesize heterogeneous catalysts, enhancing the efficacy of these MCRs through additional tactics such as increasing yield, reducing reaction time, and decreasing waste production. Nano ZnO presents multiple benefits, such as increased yields, reduced reaction time, facile catalyst separation, and the potential for reuse.

The Bizinelli reaction is a significant carbon-carbon bond-forming process in chemical synthesis for the creation of pyrimidinone and its derivatives. These represent noteworthy natural and synthetic compounds that exhibit notable pharmacological and biological features. The fused pyrimidinone with an arylidene group constitutes a significant and vital heterocyclic motif in antiviral, cytotoxic, antitumor, and anticancer medicines. The traditional Biginelli reaction has been extensively employed in the synthesis of numerous molecular collections in combinatorial chemistry. The novel approach for synthesizing arylidene heterobicyclic pyrimidinones involves the condensation reaction of aldehydes, urea or thiourea, and cyclohexanones, referred to as Biginelli-type reactions. Considering environmental and economic factors, there is a continuous initiative to substitute traditional catalysts with solid heterogeneous catalysts, mostly due to advantages such as non-toxicity, non-corrosiveness, cost-effectiveness, and ease of recovery and reuse. Surface-active metal oxides are typically employed in the manufacture of heterogeneous catalysts. The creation of efficient and environmentally sustainable synthetic methods for the swift assembly of potentially bioactive chemicals has become a primary objective for chemists in organic synthesis. Enhancing the efficacy of these MCRs by additional techniques, including yield optimization, reduced reaction time, and magnetically separable catalysts, is the pivotal element of the proposed strategy[7-9]. Consequently, as part of our ongoing efforts to establish an eco-friendly methodology for heterocyclic synthesis, we have endeavored to synthesize hexa hydro quinazolinone/thiones through the Bizinelli reaction. This involves the cyclization of aromatic aldehyde, cyclohexanone, and urea or thiourea, utilizing ethyl alcohol as the solvent and Nano ZnO as the catalyst (Scheme 1). This study presents the synthesis and characterization of Nano ZnO.

MATERIALS AND METHODS

All compounds employed in this study are of Analytical grade and used directly without further purification. Zinc nitrate and sodium hydroxide are procured from Sigma Aldrich, and throughout the experiment, doubly distilled water is employed as necessary. Zinc oxide nanoparticles are produced via the wet chemical process with zinc nitrate hexahydrate as a precursor. The rationale for selecting the wet chemical approach for synthesizing nanoZnO is to obtain nanoparticles of suitable dimensions. The commercial technical grade of Carbaryl insecticide is utilized for degradation investigations in this research.



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RESULT AND DISCUSSION

Procedure for the Synthesis of Nano ZnO

All reactions were performed under ambient conditions at room temperature. A 0.2 M solution of $\text{Zn}(\text{NO}_3)_2$ and a 0.4 M solution of NaOH were utilized to synthesis nanoZnO particles via the wet chemical method. A 500 ml beaker contained zinc nitrate dissolved in water, to which sodium hydroxide was added dropwise while stirring constantly at room temperature to produce metal hydroxides. The stirring process was maintained at 85 °C for 6 hours to acquire the as-synthesized powder. The synthesized powder was calcined in a muffle furnace at 600°C for 2 hours, followed by cooling of the furnace. The resultant product was studied using X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDAX) [9,10].

Characterization of Catalyst

FTIR (Fourier Transform Infrared) spectroscopy (Perkin Elmer- Spectrum RX-IFTIR) was utilized to ascertain the functional groups in the produced product. X-Ray diffraction patterns were obtained using a Bruker X-Ray Diffractometer with graphite-filtered CuK radiation ($\lambda=1.54 \text{ \AA}$) at 40 kV and a scanning rate of 3°/min (from $2\theta=20-80^\circ$). Optical absorption spectra were obtained using a UV-Vis spectrometer (Shimadzu). The morphology and size of the particles were assessed using a 200 KeV Transmission Electron Microscope (TECNAI 200 Kv TEM - Fei, Electron Optics). The elemental composition of particles was ascertained by SEM-EDAX (JEOL JSM 5600, EDS Model: INCA Oxford).

Fourier Transform-Infra Red Spectroscopy (FT-IR)

FT-IR analysis was conducted using optimal settings to ascertain the bond structure and associated functional groups of the produced ZnO nanoparticles. The FTIR absorption spectra of the produced particles were characterized throughout the 4000-400 cm^{-1} wavenumber region (Figure 3). The band at 436 cm^{-1} is ascribed to the Zn–O stretching mode of the ZnO lattice [9,10]. The bands at 3466 cm^{-1} correspond to the O–H vibrational mode. The C=O bond displays a pronounced asymmetric vibrational mode within the range of 1633 to 1558 cm^{-1} . The symmetric stretching transpires between 1508 and 1378 cm^{-1} due to the presence of C–O. The C–O–C peak is also present there.

X-Ray Diffraction (XRD)

Figure 4 illustrates the XRD spectrum of Zinc Oxide. The pronounced diffraction peak indicates the degree of crystallinity and the optimal size of the particles. The diffraction angle of 2θ was scanned within the range of 20° to 80° . The peaks were observed at 31.71, 34.37, 36.19, 47.49, and 56.51, corresponding to the reflecting planes (100), (002), (101), (110), and (200) respectively. All diffraction peaks exhibit a high correlation with the documented JCPDS (Joint Committee on Powder Diffraction Standards) pertaining to the hexagonal wurtzite crystal phase of zinc oxide.

Scanning Electron Microscopy- Energy Dispersive X-Ray Analysis (SEM-EDX)

Figures 5 and 6 illustrate the SEM and EDX of the produced nanoZnO, respectively. The morphological structure of the produced zinc oxide nanoparticles was verified by SEM (Figure 5), and the elemental composition was validated by EDX (Figure 6) [11-13]. The EDX spectra confirm the presence of Zn and O, with no additional contaminants found.

Transmission Electron Microscope (TEM)

Figure 7 illustrates the Transmission Electron Microscope image of nanoZnO. The samples were extensively investigated using TEM to determine the shape and precise size of the particles. The TEM picture of nanoZnO reveals the presence of hexagonal wurtzite with a size of around 50 nm. The current dimensions of the nanoparticles were determined to be approximately 30 nm. The TEM picture indicates that the nanoparticle's morphology is hexagonal wurtzite.



Satheesh *et al.*,**One pot synthesis of hexahydroquinazolin-2(1H)-one/thiones**

Aromatic aldehyde (10 mmol), urea/thiourea (12 mmol), cyclohexanone (10 mmol), and nanoZnO (500 mg), previously activated in a microwave oven for 2 minutes, were combined in a 50 ml round-bottom flask, to which 5 ml of ethyl alcohol was added as the solvent. The reaction mixture was refluxed at 80 °C for 10 minutes. The reaction's progress was assessed using thin layer chromatography (n-Hexane, Ethyl acetate 5:1). Upon completion of the reaction, the catalyst was extricated from the reaction mixture using an external magnet. The reaction mixture was concentrated using a rotary evaporator, and the solid product was recrystallized from hot ethanol many times to obtain a pure product. The relevant products were verified using FT-IR, ¹H-NMR, and mass spectral analysis. Table 1

Plausible mechanism for the formation of hexahydroquinazolin-2(1H)-one/thiones

The proposed process for the changes catalyzed by Nano ZnO particles is illustrated in Scheme 2, as inferred from analogous investigations documented in the literature. The literature indicates that the Knoevenagel-type reaction of benzaldehyde with cyclohexanone yields benzyldiene 4. Subsequent treatment of benzyldiene 4 with benzaldehyde yields α,α -bis(benzyldiene cyclohexanone 6). Subsequently, molecule 6 undergoes intramolecular cyclization to provide intermediate 7. From stage 7, a water molecule is removed to form the product hexa hydro quinazolinone / thiones 5(Scheme 2).

Spectral data for the synthesized hexahydroquinazolin-2(1H)-one/thiones**8-benzyldiene-4-phenyl-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one 5(a)**

White solid, M.P: 122°C; IR(KBr) : 3444-3315 cm⁻¹ (N-H str), 1664, 1606 cm⁻¹ (C=O Str), 1541, 1450 cm⁻¹ (Aromatic , C=C Str); ¹H NMR (400 mHz, CDCl₃): δ 1.28-1.82 (m, 2H, CH₂), 3.92-3.96 (m, 4H, CH₂), 7.02 (m, 2H, NH), 7.04(s,1H, =CH) 7.39 , 7.41-7.77 (m, 10H, Ar-H); ESI-MS m/z(%) :319 ([M+H]⁺ 100).

8-(4-bromobenzyldiene)-4-(4-bromophenyl)-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one 5(b)

White solid, M.P: 127°C; IR(KBr) : 3443, 3308 (N-H str), 1659, 1603 (C=O Str), 1538, 1485 (Aromatic , C=C Str), 694, 589 (-Br Str); ¹H NMR (400 mHz, CDCl₃): δ 1.61-1.70 (m, 2H, CH₂), 3.91-3.96 (m, 4H, CH₂), 4.68 (m, 1H, CH), 7.02 (m, 2H, NH), 7.04(s,1H, =CH), 7.23, 7.47-7.87 (m, 8H, Ar-H) ; ESI-MS m/z(%) : 477 ([M+H]⁺ 100).

8-(2-nitrobenzyldiene)-4-(2-nitrophenyl)-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one 5(c)

White solid, M.P: 142°C; IR(KBr) : 3478, 3361(N-H str), 1673 (C=O Str), 1594, 1516(Aromatic , C=C Str), 1372, 1341 (-NO₂ Str); ¹H NMR (400 mHz, CDCl₃): δ 1.62 (m, 6H, CH₂), 7.28 (m, 2H, NH), 7.28 (s, 1H, =CH), 7.78-7.84 (m, 8H, Ar-H) ; ESI-MS m/z(%) :409 ([M+H]⁺ 100).

8-(4-methoxybenzyldiene)-4-(4-methoxyphenyl)-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one 5(d)

White solid, M.P: 136°C; IR(KBr) : 3441, 3334 (N-H str), 1667, 1602 (C=O Str), 1542, 1510 (Aromatic , C=C Str), 1028 (-OCH₃ Str); ¹H NMR (400 mHz, CDCl₃): δ 1.62-1.71 (m, 2H, CH₂), 2.36-3.95 (m, 4H, CH₂), 3.82 (m, 3H, -OCH₃), 3.91 (s, 1H, CH) 6.79-6.89 (m, 2H, NH), 7.02-7.04 (s, 1H, CH), 7.28 -7.87 (m, 8H, Ar-H) ; ESI-MS m/z(%) :379 ([M+H]⁺ 100).

8-(2-chlorobenzyldiene)-4-(2-chlorophenyl)-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one 5(e)

White solid, M.P: 128°C; IR(KBr) : 3433, 3308 (N-H str), 1664, 1606 (C=O Str), 1526,1440 (Aromatic , C=C Str), 752, 724 (-Cl Str); ¹H NMR (400 mHz, CDCl₃): δ 1.74-1.90 (m, 2H, CH₂), 2.34 (m, 4H, CH₂), 3.91 (s, 1H, CH) , 7.02(m, 2H, NH), 7.04 (m, 1H, CH), 7.28-7.98 (m, 8H, Ar-H) ; ESI-MS m/z(%) :387 ([M+H]⁺ 100).

8-benzyldiene-4-phenyl-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-thione 5(f)

White solid, M.P: 126°C; IR(KBr) : 3379 (N-H str), 1479, 1409 (Aromatic , C=C Str) , 1085 (C=S Str); ¹H NMR (400 mHz, CDCl₃): δ 3.92-3.96 (m, 6H, CH₂), 7.02(m, 2H, NH), 7.04 (m, 1H, CH), 7.28-7.88 (m, 10H, Ar-H) ; ESI-MS m/z(%) : 335 ([M+H]⁺ 100).





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8-(2-hydroxybenzylidene)-4-(2-hydroxyphenyl)-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione 5(g)

White solid, M.P: 145°C; IR(KBr) : 3375 (N-H str), 3171, 2866 cm^{-1} (-OH str), 1470, 1412 (Aromatic , C=C Str) , 1217 (C=S Str); ^1H NMR (400 MHz, CDCl_3): δ 1.59 (m, 6H, CH_2), 3.92-3.96 (s, 1H, CH) 7.04(m, 2H, NH), 7.05 (m, 1H, CH), 7.28-7.80 (m, 8H, Ar-H); ESI-MS $m/z(\%)$: 367 ($[\text{M}+\text{H}]^+$ 100).

8-(2-methoxybenzylidene)-4-(2-methoxyphenyl)-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione 5(h)

White solid, M.P: 138°C; IR(KBr) : 3379 (N-H str), 1541, 1466 (Aromatic , C=C Str) , 1246 (C=S Str), 1020, 1045 (-OCH₃ Str); ^1H NMR (400 MHz, CDCl_3): δ 2.34-2.37 (m, 6H, CH_2), 3.95 (s, 1H, -CH) , 7.00 (m, 2H, NH), 7.07 (m, 1H, CH), 7.28-7.86 (m, 8H, Ar-H) ; ESI-MS $m/z(\%)$:395 ($[\text{M}+\text{H}]^+$ 100).

8-(2-nitrobenzylidene)-4-(2-nitrophenyl)-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione 5(i)

White solid, M.P: 153°C; IR(KBr) : 3376 (N-H str), 1525, 1473 (Aromatic , C=C Str) , 1345 (-NO₂ Str), 1268, 1190 (C=S Str); ^1H NMR (400 MHz, CDCl_3): δ 1.61, 3.91 (m, 6H, CH_2), 3.95(s, 1H, -CH), 7.02 (m, 2H, NH), 7.04 (m, 1H, CH), 7.28-7.84 (m, 8H, Ar-H) ; ESI-MS $m/z(\%)$:425 ($[\text{M}+\text{H}]^+$ 100).

8-(2-chlorobenzylidene)-4-(2-chlorophenyl)-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione 5(j)

White solid, M.P: 138°C; IR(KBr) : 3320 (N-H str), 1541, 1488(Aromatic , C=C Str) , 1262, 1152 (C=S Str), 727, 632 (-Cl Str); ^1H NMR (400 MHz, CDCl_3): δ 1.74, 2.34-2.38 (m, 6H, CH_2), 3.51-3.96 (m, 1H, CH) 7.02 (m, 2H, NH), 7.04 (m, 1H, CH), 7.33-7.98 (m, 8H, Ar-H) ; ESI-MS $m/z(\%)$: 404 ($[\text{M}]^+$ 100).

Effect of loading of catalyst on the synthesis of hexahydroquinazolin-2(1H)-one/thiones

The current reaction was examined with varying quantities of catalyst. The findings indicate that 500 mg of catalyst suffices to provide a satisfactory yield of the product. Further increases in catalyst quantity will not result in a significant change in product yield. Consequently, 500 mg of catalyst was utilized to conduct the reaction. This study selected a mixture of benzaldehyde, urea, and cyclohexanone in ethyl alcohol as the model reaction (Scheme 1). The findings are presented in Table 2.

Effect of solvent on synthesis of hexahydroquinazolin-2(1H)-one/thiones:

The investigation of the reaction medium indicated that solvents play a significant role in the reaction. The findings are encapsulated in Table 3. Polar solvents, including acetic acid, CH_3CN , and $\text{C}_2\text{H}_5\text{OH}$, were determined to be significantly superior to non-polar solvents. Minimal yield detected when H_2O served as the solvent, perhaps attributable to the agglomeration of the hydrophobic catalyst. Despite the efficacy of CH_3COOH , a poor yield was achieved upon catalyst reutilization. Consequently, we opted on ethyl alcohol.

Effect of Temperature on Synthesis of hexahydroquinazolin-2(1H)-one/thiones

The reaction temperature for the synthesis of hexahydroquinazolinone/thiones using Nano ZnO catalyst is 80 °C, as indicated in Table 4. It is noted that at temperatures below 80 °C, the product yield is low and the reaction time is prolonged. We have verified that 80 °C is an appropriate temperature for this reaction.

Recycling of the Catalyst

The reusability of catalysts is a critical aspect of heterogeneous catalysis. Catalyst recycling was accomplished by magnetically securing the catalyst at the base of the reflux flask using a powerful Neodymium magnet. Subsequently, the product-containing solution was extracted with a pipette, the catalyst was washed three times with ethyl acetate, dried, and fresh reactants dissolved in ethyl alcohol were added to the round-bottom flask, followed by refluxing to facilitate the subsequent reaction cycle. The catalyst was utilized sequentially five times without any significant loss of catalytic activity. (Table 5)





CONCLUSION

Nano ZnO has effectively served as a catalyst for the Bizinelli reaction involving aromatic aldehydes, urea/thiourea, and cyclohexanone. The employment of this catalyst offers numerous benefits. High yield, straightforward catalyst preparation, little catalyst loading, convenient operation, absence of by-product formation, and ease of catalyst recycling and reuse. The primary contribution of this study was the effective synthesis of Nano ZnO, which demonstrates a balance between recyclability and activity in the Bizinelli reaction.

Declarations

Competing interests: There are no competing interests

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Table 1 Synthesis of hexahydroquinazolin-2(1H)-one/thiones

S.No.	Product	Time(min)	Yield(%)
1	8-benzylidene-4-phenyl-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one(5a)	10	96
2	8-(4-bromobenzylidene)-4-(4-bromophenyl)-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one(5b)	10	96
3	8-(2-nitrobenzylidene)-4-(2-nitrophenyl)-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one(5c)	12	95
4	8-(4-methoxybenzylidene)-4-(4-methoxyphenyl)-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one(5d)	11	96
5	8-(2-chlorobenzylidene)-4-(2-chlorophenyl)-3,4,5,6,7,8-hexahydroquinazolin-2(1H)-one(5e)	11	96
6	8-benzylidene-4-phenyl-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione(5f)	12	96
7	8-(2-hydroxybenzylidene)-4-(2-hydroxyphenyl)-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione (5g)	11	96
8	8-(2-methoxybenzylidene)-4-(2-methoxyphenyl)-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione(5h)	11	94
9	8-(2-nitrobenzylidene)-4-(2-nitrophenyl)-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione(5i)	12	95
10	8-(2-chlorobenzylidene)-4-(2-chlorophenyl)-3,4,5,6,7,8-hexahydroquinazoline-2(1H)-thione(5j)	10	96

Table 2 Effect of catalyst loading on the formation of hexahydroquinazolin-2(1H)-one/thiones

S.No.	Name of the catalyst	Catalyst loading in (mg)	Time (min.)	Yield (%)
1	Nano ZnO	200	10	52
2	Nano ZnO	300	10	66
3	Nano ZnO	400	10	78
4	Nano ZnO	500	10	96
5	Nano ZnO	600	10	96

Table 3: Effect of Solvent on the formation of hexahydroquinazolin-2(1H)-one/thiones.

S.No.	Catalyst	Solvent	Time(min)	Yield(%)
1	Nano ZnO	H ₂ O	110	trace
2	Nano ZnO	CH ₂ Cl ₂	75	40
3	Nano ZnO	CH ₃ COOH	50	75
4	Nano ZnO	CH ₃ CN	30	85
5	Nano ZnO	C ₂ H ₅ OH	10	96

Table 4:Effect of Temperature on the formation of hexahydroquinazolin-2(1H)-one/thiones

S.No.	Catalyst	Temperature (°C)	Time (min)	Yield (%)
1	Nano ZnO	R.T.	150	20
2	Nano ZnO	45	80	60





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3	Nano ZnO	65	35	75
4	Nano ZnO	80	10	96

Table 5 Recyclability of the catalyst in the reaction, synthesis of hexahydroquinazolin-2(1H)-one/thiones

S.No.	Name of the catalyst	Run No.	Yield (%)
1	Nano ZnO	1	96
2	Nano ZnO	2	93
3	Nano ZnO	3	92
4	Nano ZnO	4	91
5	Nano ZnO	5	90

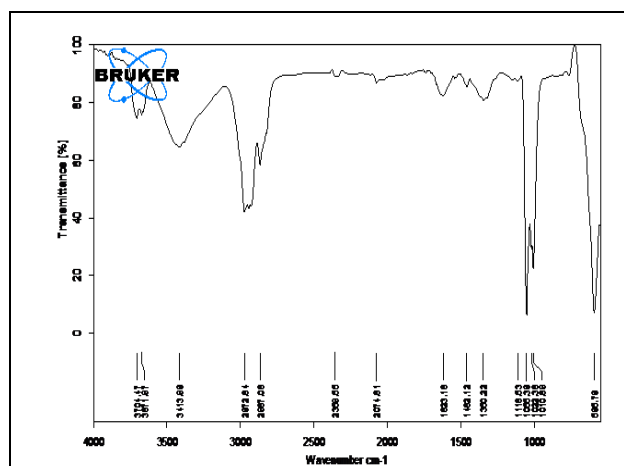


Figure 1: FT-IR spectrum of nanoZnO

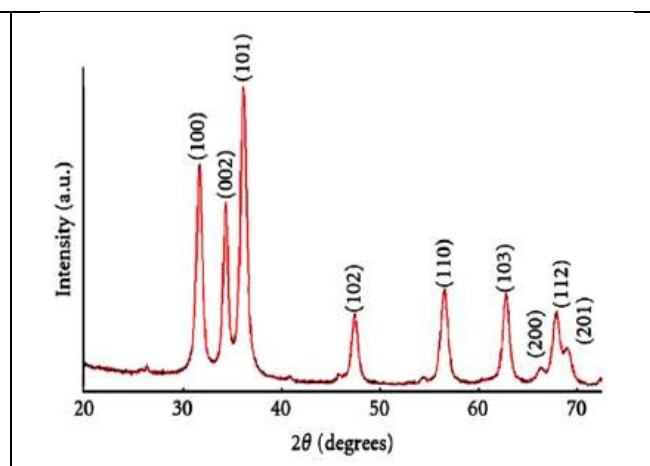
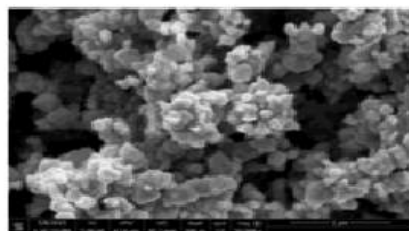
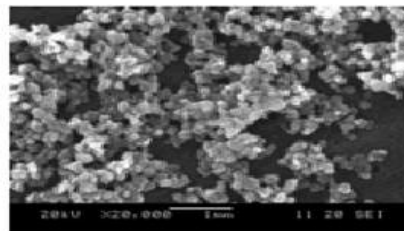


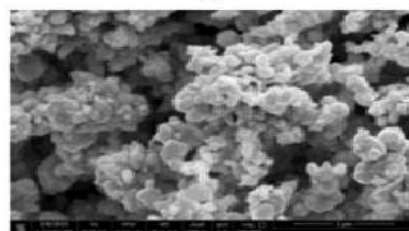
Figure 4: XRD pattern of Nano ZnO



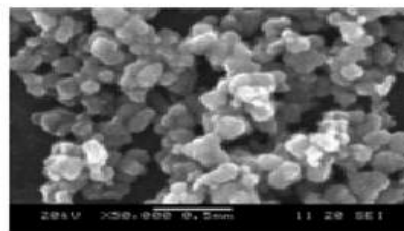
(a)



(b)



(c)



(d)

Figure 5: SEM images of nanoZnO



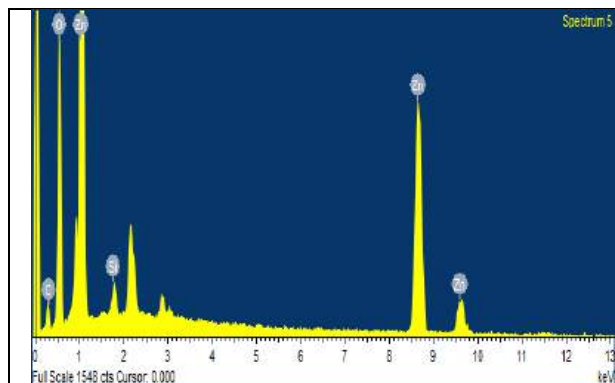
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Figure 6: EDX spectrum of nanoZnO

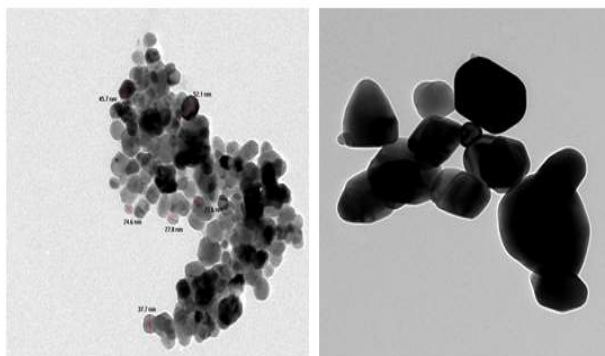
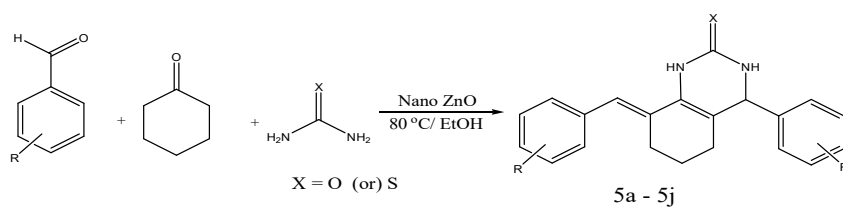
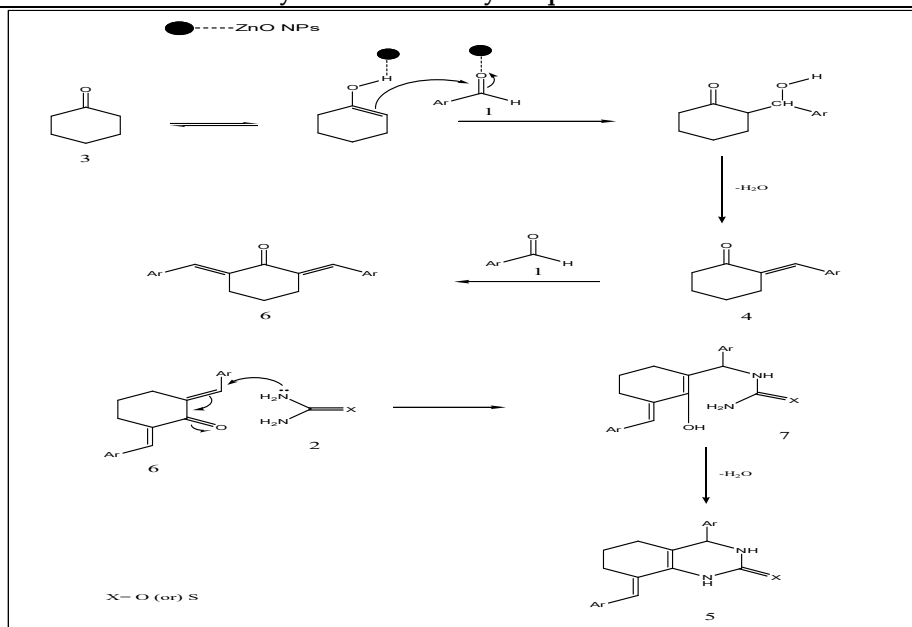


Figure 7: TEM images of nanoZnO

5a-5e : $X = O$, $R = H$, 4-Br, 2- NO_2 , 4- OCH_3 , 2-Cl5f-5j : $X = S$, $R = H$, 2-OH, 2- OCH_3 , 2- NO_2 , 2-Cl

Scheme 1. Synthesis of hexa hydro quinazolinone/thiones.



Scheme 2 Plausible mechanism for the formation of hexahydroquinazolin-2(1H)-one/thiones





Malaria Detection Using Deep Learning Techniques

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ABSTRACT

Malaria, a parasitic disease caused by Plasmodium parasites, can cause serious health risks, including fever and possibly even death, and is transmitted by the bite of an infected Anopheles mosquito. This technique employs deep neural networks to automate the identification of malaria in blood cells, addressing the limitations of traditional methods that rely on skilled workers and microscopes. The study makes use of the NIH Malaria Dataset, which contains 27,558 segmented images of red blood cells that are both parasitized and uninfected. Three CNN models are evaluated using accuracy, precision, recall, and F1 score: Basic CNN, VGG-19 Frozen CNN, and VGG-19 Fine Tuned CNN. Model performance is enhanced by data preprocessing techniques like segmentation and normalization. The goal is to identify the best model for accurate malaria detection.

Keywords: Anopheles mosquitoes, segmentation, accuracy, VGG-19, and automated detection.

INTRODUCTION

The parasite Plasmodium causes malaria, which is spread by mosquito bites. Plasmodium falciparum is the parasite that causes the most severe and occasionally fatal episodes of malaria. Although they have lower death rates [3,9], other species such as *P. malariae*, *P. vivax*, *P. ovale*, and *P. knowlesi* can also cause serious sickness. Malaria kills 1.5–2.7 million individuals worldwide each year and affects 300–500 million people. WHO estimates that 219 million cases of malaria and 435,000 fatalities from the disease occurred globally in 2017[3]. In remote places with limited access to healthcare and effective diagnosis, the condition is more common. Currently, thick and thin stained blood smears are



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used in light microscopy, which is the commonly accepted approach for diagnosing malaria [4]. Nevertheless, this approach is very dependent on proficient technicians, who are frequently few, particularly in areas where malaria is prevalent [5]. A research conducted in Ghana, for example, found that there were only 1.72 microscopes and 0.85 qualified laboratory personnel per 100,000 persons, which resulted in erroneous and delayed diagnoses [6]. Healthcare professionals frequently depend solely on clinical symptoms, which can result in incorrect diagnoses, needless medication use, and increasing drug resistance[7,8]. In order to ensure prompt treatment and avoid serious complications, early and precise diagnosis is essential[10]. An automated, dependable diagnostic model that can operate without the requirement for highly skilled specialists is becoming more and more necessary[1,2,7,11]. This kind of solution could lessen the strain on healthcare institutions and improve diagnostic accuracy, particularly in underprivileged areas.

METHODOLOGY

Convolutional Neural Network

Convolutional neural networks (CNNs) are a type of artificial neural network that is widely utilized in deep learning tasks like image classification, segmentation, and localization[1,7]. CNNs are designed with picture identification and processing in mind[2]. Convolution layers, filters (kernels), pooling, and fully connected layers are combined using these techniques to extract features and classify objects from input photos that have been processed as pixel arrays[1,2]. Their exceptional precision in identifying patterns has revolutionized the field of image identification, rendering them perfect for uses in medical image diagnostics, video analysis, and facial recognition, among other applications[8,9]. In addition to image processing[2,6], CNNs are also used in voice recognition[11], video classification, and obstacle detection in self-driving cars[7].

Convolutional Neural Network Pre-Trained Model VGG-19

The Oxford Visual Geometry Group created the 19-layer deep Convolutional Neural Network (CNN), or VGG-19, which is used for picture classification[7,8]. It consists of three fully connected layers, five max-pooling layers, and sixteen convolutional layers[7]. A variation of the VGG models, which also include VGG-11 and VGG-16[8], is called VGG-19. Transfer learning is performed to the ImageNet dataset, which has more than 14 million images[9], in order to optimize the model for particular applications such as malaria detection. For training and classification tasks, the model employs binary cross-entropy, Adam optimizer, and ReLU activation functions[1,2,9].

VGG-19 Frozen Model

The Oxford Visual Geometry Group created the 19-layer deep Convolutional Neural Network (CNN), or VGG-19, which is used for picture classification[7,8]. It consists of three fully connected layers, five max-pooling layers, and sixteen convolutional layers[7]. A variation of the VGG models, which also include VGG-11 and VGG-16[8], is called VGG-19. Transfer learning is performed to the ImageNet dataset, which has more than 14 million images[9], in order to optimize the model for particular applications such as malaria detection. For training and classification tasks, the model employs binary cross-entropy, Adam optimizer, and ReLU activation functions[1,2,9].

VGG-19 Fine-Tuned Model

Convolutional neural networks (CNNs) can be optimized by using pre-trained weights to train a new model[7,8], which is especially useful for small datasets. Techniques include training at a reduced learning rate, usually 10 times lower, and replacing the final layer[1,2] with a new SoftMax layer. While the first layers capture common features like edges and curves, their weights are locked[9]. Using pre-trained ImageNet weights with VGG-19 in Keras[8,9], the layers are improved. After being condensed into a one-dimensional array, the data is added to the dense layer[2], which is fully connected. A dropout layer is added, randomly deactivating neurons during training[1,9], to prevent overfitting.



**Gedela Triveni et al.,****Implementation**

Jupyter Notebook and Python 3.8[1,2] were used to process 27,557 photographs, 13,778 parasitized and 13,779 healthy, in order to find malaria parasites. Three groups of photos were created: 60% for training, 10% for validation, and 30% for testing. In order to attain a balance between computational effectiveness and precision, the pictures were reduced to [64, 64]. The contour detection function of OpenCV allowed for the detection of dark patches within cells[6,7], and threading via Thread Pool Executor allowed for the simultaneous loading and processing of images[8]. The three neural networks utilized for the predictions were a basic CNN, a frozen pretrained CNN (VGG), and a fine-tuned pre-trained CNN with data augmentation [9,10,11]. Examples of photos with parasites from malaria and in good health. Using Keras and TensorFlow, the Basic CNN was built with Conv2D layers and max-pooling for data down sampling. The model's accuracy was 0.9625 and its fifth epoch loss was 0.1129, yielding 15,102,529 trainable parameters. Similar training was performed on the VGG19 model, which has 22,647,367 total parameters. After five epochs, the model produced an accuracy of 0.9196 and a loss of 0.2118. In order to fine-tune, the final layer was replaced with a new softmax layer, and the learning rate was lowered. Important features were preserved by freezing the initial layers. To avoid overfitting, dropout was used together with flattening the data for categorization.

Suggested Work Algorithm

Step 1: Gather all of the previously edited images and group them into a single file for convenience of transfer.

Step 2: Separate the images into train and test groups using sklearn.

Step 3: To understand the image parameters and use the contour detection technique, use OpenCV on the images.

Step 4: Use a thread pool executor to process the image in order to circumvent time limits.

Step5: Create a blank Basic CNN model and fit it to the data.

Step 6: Use the Keras and Tensor Flow packages to run the model after inserting the photos. Step 7: Utilize the equation $\text{Epoch} = (\text{number of iterations} * \text{batch size}) / \text{total number of training images}$.

Step 8: Verify the accuracy; if not enough, move on to the next CNN model. Step 9: Fit the data to the Frozen CNN model that you created. It is necessary to repeat steps 6-7.

Step 10: Verify the accuracy; go on to the next CNN model if it's not accurate enough. Step 11: Fit the CNN model that has been fine-tuned to the dataset. It is recommended to model and repeat steps 6-7.

Step 12: Determine the accuracy rate here if the accuracy is adequate.

Experimental Results**RESULTS**

Red blood cell images can be categorized as either healthy or diseased. Various pre-trained Convolutional Neural Networks (CNNs) are fine-tuned via transfer learning using the malaria dataset, and their performances are recorded [1,2]. The application of different pre-processing strategies such as scaling, stain standardization, and normalization does not significantly alter the model performance on CNN and VGG-19; on the other hand, the data augmentation methodology has demonstrated promising results [3]. To find the best performing model, the CNN and VGG-19 performances were compared. With data augmentation, CNN's accuracy is 95% [4]. After the model is adjusted and the data augmentation technique is applied to the testing dataset, the basic VGG-19 frozen model obtains 92% accuracy; however, after that, it achieves 96% accuracy [1,2]. After fine-tuning and data augmentation [5,6], transfer learning is a great technique that can produce promising results; in our studies, it can obtain the highest accuracy of 96% using VGG19.

CONCLUSION

The conventional approach to diagnose malaria involves having lab personnel or trained technicians look under a microscope at human blood smears to check for parasite-infected red blood cells. The diagnosis is based on the expertise and experience of the individual conducting the examination, which makes the technique ineffective. It is feasible to quickly and with high accuracy develop a deep learning model that predicts malaria. Three different types





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of models are used to evaluate the performance of the malaria parasitized models. The accuracy was 92% in the VGG19 frozen network and 95% in the first model, which is a standard CNN model. Consequently, in the third model, VGG19 is adjusted and data augmentation is carried out in order to improve accuracy and performance. This leads to an accuracy of 96%. Compared to previous models, this huge data model performed well, and the evaluation and performance of the model will be promising for smaller data sets. Thus, without suffering any losses, the model can identify malaria in a parasite. Interesting challenges are obtained for the detection of malaria parasitized detection.

Future Work

CNN will be utilized in the future to identify diseases like pneumonia and breast cancer in addition to helping to prepare for the identification of COVID-19 smears in human lungs.

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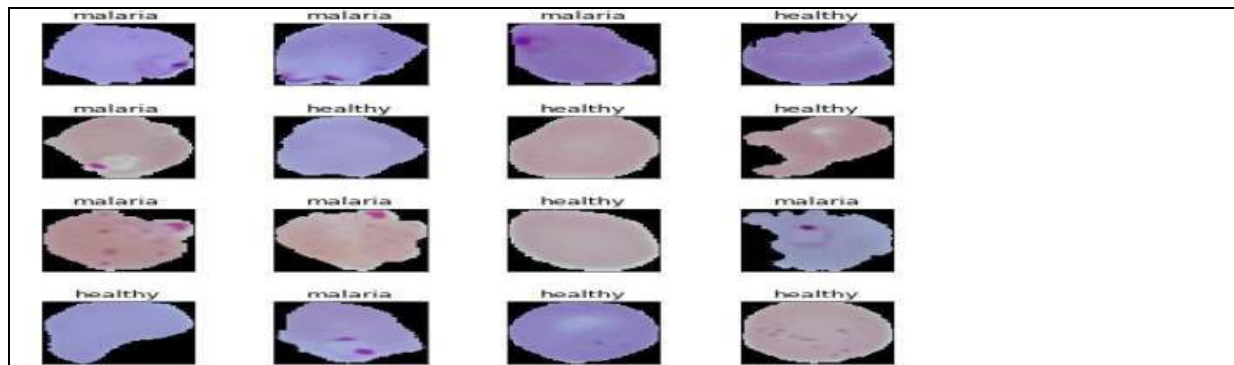


Figure.1. Malaria cell Images

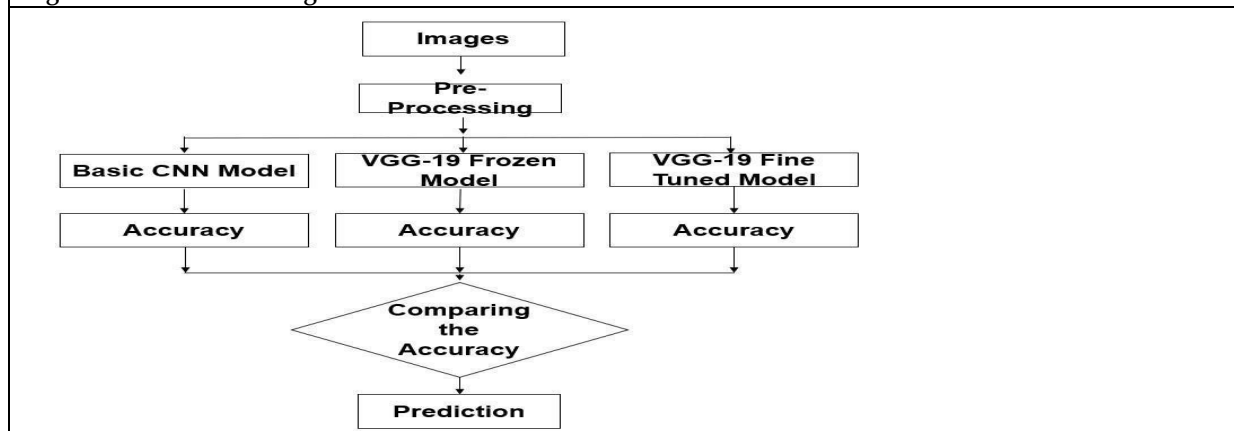


Figure.2. Block Diagram

	Accuracy	Precision:	Recall	F1 Score:
Basic CNN	0.9511	0.9525	0.9511	0.9511
VGG-19 Frozen	0.9193	0.9218	0.9193	0.9192
VGG-19 Fine-tuned	0.9609	0.9616	0.9609	0.9609

Figure.3. Model performance





Game-Based Learning vs. Traditional Methods: A Comparative Study in Language Acquisition

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ABSTRACT

This study investigates the effectiveness of game-based learning (GBL) and traditional methods in language acquisition among secondary language learners. GBL incorporates elements from games to make learning engaging, and fun, with challenges, rewards, and points to motivate learners. The study evaluates the impact of both approaches on vocabulary retention, grammar proficiency, speaking, and listening skills. Results show that GBL significantly improves learner engagement and communication skills, while traditional methods excel in grammar accuracy. The findings suggest that a hybrid approach, combining the strengths of both methods, may be the most effective solution for language learning.

Keywords: Game-based learning, language acquisition, vocabulary retention, grammar proficiency, speaking skills, listening skills, learner engagement, communication skills, hybrid approach.

INTRODUCTION

Language acquisition has always been a central focus in education, especially in second language learning. For decades, traditional methods such as the grammar-translation approach, direct method, and audio-lingual practices have dominated language classrooms. These methods focus on structured learning, emphasizing grammar, syntax, and linguistic accuracy. However, with the increasing integration of technology in education, innovative approaches like game-based learning (GBL) have emerged as potential alternatives to traditional techniques. Researchers' attention has been drawn to the growing use of gamification features in the educational context in recent years. By gamifying learning systems, there is a significant chance to improve students' learning performance as an informative activity on its own (Dichev and Dicheva 2017; Landers and Landers 2014; Ortiz-Rojas *et al.* 2017). The objective is to engage students in learning activities that will favorably impact learning outcomes and lessen their sense of boredom with certain tasks in order to inspire them in new ways (Hanus and Fox 2015). [1] Game-based



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learning integrates game mechanics—such as point systems, rewards, and challenges—into educational environments to make learning more interactive and engaging. In the context of language learning, GBL has been praised for improving student motivation and enhancing language retention. This study seeks to compare the efficacy of game-based learning and traditional methods in language attainment, focusing on learners' proficiency in vocabulary, grammar, speaking, and listening skills.

Traditional Methods

Traditional language learning methods, especially the translation of grammar method, focus on the written language. Learners translate texts from their native language to the target language and vice versa. This method, while systematic and structured, has often been criticized for its lack of emphasis on communication and real-life language use. Another conventional strategy, the audio-lingual method, uses repeated drills to help learners internalize language patterns. It places more emphasis on correctly applying grammatical structures than on using language creatively, which is crucial in everyday contexts. Conventional method of instruction In order to review and apply the material from the pertinent statistics lecture, students were required to attend a weekly 90-minute practical class for the "Research Methods and Statistics" module. During the practical session, students were initially provided with a brief overview of the test's assumptions and a basic hypothetical case study. A few questions on the design, data level, and statistical distribution were given to them to answer. They were also required to compute descriptive and inferential performing manual data analysis following detailed guidance provided in a workbook. Instructions on how to include the outcome in a report were given, and they finished weekly assessments independently with the help of SPSS. This approach was designed to assist independent learning in a small learning environment with 20 students per class. [2] Prior research showed that students held different views on the effectiveness of conventional learning methods (Habibzadeh *et al.*, 2019; Lo *et al.*, 2020b; Lee, Lee, Gong, Bae, & Choi, 2016; Raja, 2018; Zaidi, Hammad, Awad, Qasem, & Al-Mahdi, 2017). Nurutdinova, Perchatkina, Zinatullina, Zubkova and Galeeva (2016) carried out a study in a fifth-grade primary school to evaluate the effectiveness of different teaching methods. The study revealed that learners had poorer critical thinking skills with traditional learning methods than with alternative strategies. Other research also found that if information is not in written form, like a book, traditional learning methods can still be effective (Alaagib, Musa, & Saeed, 2019; Balliu, 2017). Zlotskaya (2016) proposed a research project to evaluate the effectiveness of learning strategies across various learning environments. The results of the study indicated that conventional teaching methods are effective for learning, especially in the presence of a high number of students in the classroom.[4]

How is gamification different from traditional learning?

A notable distinction exists between gamification and traditional educational methods. Traditional education often compels students to engage with content that may lack relevance or entertainment value. In contrast, gamification allows learners to tailor their educational experiences, thereby fostering creativity, innovation, and intrinsic motivation. Assessment in traditional learning typically relies on grading systems to evaluate students' competencies, knowledge, and skills. Conversely, gamification employs experience points, which can be accumulated over time through various activities. This approach enables students to enhance their learning and address diverse areas for improvement. Another significant difference lies in the resources utilized; traditional learning predominantly relies on textbooks and lectures. This method often requires full integration with technology, resulting in a monotonous and disengaging experience. In contrast, gamified learning employs contemporary educational strategies, yielding reliable outcomes, facilitating the assessment of students' learning capabilities, and promoting collaboration, skill development, and problem-solving. Additionally, it transforms practical classes into engaging and enjoyable experiences. Furthermore, conventional learning typically mandates that students follow a fixed schedule. In contrast, game-based learning and gamification empower students to progress at their own pace. Game-based learning specifically involves the use of educational games, while gamification integrates game elements into non-gaming contexts. This flexibility can significantly benefit students who need extra time to comprehend specific concepts.



**Madhavi and Devika Rani****Game-Based Learning (GBL)**

GBL, rooted in constructivist and social learning theories, presents a more interactive approach to language learning. Games create an immersive environment where learners can experiment, make mistakes, and learn from those experiences without the pressure of traditional classroom settings. Research shows that GBL can significantly increase student engagement, motivation, and overall language proficiency, particularly in speaking and listening skills. In the process of learning a language, learners can use digital games and apps like Duolingo and Kahoot to work on their vocabulary, pronunciation, and grammar in a fun and interactive way. These platforms frequently include feedback systems, in which students receive rewards for their advancements and can promptly correct errors. Studies indicate that digital games have the ability to influence both brain function and behavior. They have the ability to modify areas of the brain that control visuospatial and attention abilities, enhancing their effectiveness. An additional study in 2022 with 2,000 children yielded comparable findings. Engaging in digital gaming for three hours each day resulted in improvements in cognitive abilities tested on tasks related to working memory and impulse control. Different brain regions like the hippocampus, prefrontal cortex, and cerebellum can be activated during games. Gamification and games provide significant value due to their context. Learners can earn points, compete on leaderboards against peers, and track their progress using levels and scoreboards through gamification.[1a]

Previous Studies

Studies comparing traditional methods and GBL in language learning have produced mixed results. Some have found that while GBL promotes greater engagement and retention, traditional methods provide a deeper understanding of grammatical structures. Others suggest that GBL is more effective in enhancing communication skills, particularly in speaking and listening. Researchers have characterized learning through game as voluntary, immersive, and enjoyable educational approach where learners pursue inspiring goals within set rules (Stenros, 2017). Chang and Yeh (2021) suggested that integrating educational goals into computer games can boost student learning, inspire them, and offer unique interactive learning chances. Kikot, Costa, it could be highlighted that the utilization of computer games represents a very organic form of learning. Gamification can be ability-centered learning to inspire students and enhance their academic performance. It is found that it influenced traditional learning strategies. The focus of learning shifts from the instructor to the learner, making the learners more active and engaged in the learning process. A sample research was conducted

- This research included 60 first-semester students studying English in the B.Tech program. The individuals were split into two categories:

- A total of 30 students in Group A were educated with game-based learning methods, focusing mainly on language apps and interactive games. - Group B, consisting of 30 students, received instruction through conventional techniques, which emphasized grammar exercises, reading comprehension, and translation assignments. The research lasted three months, with both groups being given identical material. Group A utilized GBL platforms like Duolingo, Memrise, and Kahoot, which included vocabulary games, pronunciation challenges, and real-world language activities. Group B utilized a curriculum centered on textbooks, emphasizing traditional techniques like reading exercises, grammar worksheets, and instructor-led classes. Both groups underwent a pre-test to assess their baseline language proficiency, followed by a post-test to measure their progress. Additionally, the students completed surveys to gauge their engagement and motivation during the study. It is observed that Games, in contrast to books or presentations, are frequently created with the intention of utilizing memory as a form of proficiency.

When engaged in game-based learning, memory is challenged across multiple layers and levels. To achieve its objectives, a game may necessitate recalling specific features of either the game itself or the subject it seeks to impart. By utilizing this approach, professionals can boost and elevate their memory. Recalling helpful or repetitive information is second nature. Game-based learning frequently emphasizes the enhancement of an individual's creativity. Game-based learning is created to promote thinking in a creative manner. It therefore fosters a mindset of unconventional thinking in professionals. Innovation and creative thinking are fundamental abilities that every individual possesses at the core. Hence, it is crucial to instill this mentality, and utilizing game-based learning is a



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highly effective method to achieve this. The majority of game-based learning tasks require quick thinking to finish. In overcoming these obstacles and succeeding in their classes, players need to employ logical thinking and anticipate future steps. One of the key benefits of game-based learning compared to traditional learning is the ability to anticipate and plan based on logic. This assists people in acquiring the ability to solve problems in a fast and innovative way.[2a]

DISCUSSION

It is observed that game-based learning can significantly enhance vocabulary acquisition, speaking fluency, and listening comprehension. GBL provides learners with interactive and engaging ways to practice language skills, which traditional methods may lack. The game mechanics, such as immediate feedback, progress tracking, and rewards, seemed to motivate learners and enhance retention. However, traditional methods still hold value, particularly in grammar instruction. Group B performed better in grammar-related tasks, likely due to the structured and repetitive nature of traditional grammar exercises, which drilled specific language rules and patterns into learners.

CONCLUSION

This study demonstrates that game-based learning is an effective tool for enhancing certain aspects of language acquisition, particularly vocabulary, speaking, and listening. However, traditional methods remain valuable for teaching grammar and providing structured learning environments. A hybrid approach, combining the strengths of both GBL and traditional methods, may provide the most comprehensive and effective language learning experience. Future research should explore the integration of GBL into traditional curriculums, investigating how the two methods can complement each other to address various learning needs and preferences. Game-based learning or gamification for e-learning is a useful and effective way for professionals to learn and develop new skills. By adding game-like elements to a learning setting, individuals can improve their memory, enhance their creative and problem-solving abilities, and better understand concepts through practical application.

Blogs

1. <https://spinify.com/blog/how-gamification-is-different-from-traditional-learning/> [1a]
2. <https://imarticus.org/blog/4-reasons-game-based-learning-is-better-than-traditional-learning/> [2a]

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The Role of Mechanical Strain in Enhancing BTBT in Silicon Devices: A Review

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ABSTRACT

Band-to-band tunneling (BTBT) has emerged as a promising mechanism to push the boundaries of semiconductor device performance, especially as conventional metal-oxide-semiconductor field-effect transistor scaling approaches its physical limits. One of the most promising alternatives, the tunneling FET, uses quantum mechanical tunneling for carrier injection, offering advantages such as low power dissipation and scalability. This review focuses on recent advancements in BTBT in silicon devices, with a special emphasis on how mechanical strain can modify band structures and enhance tunneling currents. The review consolidates theoretical models and experimental results from various studies, providing a comprehensive view of how mechanical uniaxial stress can be applied to optimize device performance.

Keywords: BTBT, Stain, tunneling FET, MOSFET, WKB approximation

INTRODUCTION

The rapid growth and success of the electronics industry over the past few decades can largely be attributed to the relentless scaling of transistors, following Moore's Law. This empirical observation, first introduced by Gordon Moore in 1965, predicted that the number of transistors on a chip would double approximately every two years, leading to exponential increases in computing power. The semiconductor industry has adhered to this scaling roadmap, which has fueled remarkable advances in technology, ranging from personal computing to mobile devices, telecommunications, and artificial intelligence (AI) applications[1], [2]. At the heart of this technological progress lies the metal-oxide-semiconductor field-effect transistor (MOSFET), the fundamental building block of VLSI systems. VLSI technology has enabled the integration of millions to billions of transistors on a single chip, drastically improving the functionality, speed, and energy efficiency of integrated circuits (ICs). MOSFETs, which form the core of modern VLSI systems, operate by modulating the flow of electrons or holes between the source and drain



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terminals via a gate-controlled electric field. The scaling of MOSFETs has traditionally followed Dennard's scaling law, which states that as transistors shrink in size, both power density and switching speed improve proportionally. This scaling has driven the electronics industry, enabling smaller, faster, and more power-efficient devices with each successive generation of technology nodes.

However, as MOSFET dimensions have shrunk into the nanometer regime, fundamental physical limitations have begun to challenge further scaling. The main issues include increased power consumption due to leakage currents, short-channel effects, and the inability to reduce the supply voltage without compromising performance. These limitations stem from the thermal energy barrier that MOSFETs rely on to switch between the "on" and "off" states, which imposes a theoretical limit on the sub-threshold slope (SS) of 60 mV/decade at room temperature[3], [4]. As a result, the conventional MOSFET is facing diminishing returns in terms of power efficiency, which has prompted researchers to explore alternative transistor architectures. One of the most promising alternatives is the tunneling FET a device that operates on fundamentally different principles compared to MOSFETs. Instead of relying on thermionic emission over an energy barrier, tunneling FETs utilize band-to-band tunneling, a quantum mechanical phenomenon where charge carriers (electrons or holes) tunnel through an energy barrier rather than overcoming it. In a tunneling FET, when a gate voltage is applied, it modulates the tunneling probability between the source and drain, enabling the device to switch between "on" and "off" states with potentially much lower voltage thresholds. This mechanism allows TFETs to achieve an SS below the 60 mV/decade limit of MOSFETs, making them highly attractive for ultra-low-power applications[5][6].

Tunneling FETs offer several distinct advantages over MOSFETs. The most notable is their ability to operate at lower supply voltages, significantly reducing power consumption, which is critical in modern electronics where energy efficiency is paramount. Additionally, Tunneling FETs exhibit weak temperature dependence in their switching characteristics due to the quantum tunneling process, making them suitable for applications in extreme environments. Moreover, because the BTBT process is less affected by short-channel effects, TFETs can potentially scale to even smaller dimensions than MOSFETs, further extending the benefits of Moore's Law into the future[7]. Despite these advantages, Tunneling FETs face several challenges that have hindered their widespread adoption, the most significant of which is their relatively low on-current. The low on-current arises from the fact that tunneling efficiency is strongly dependent on the energy bandgap of the semiconductor material. In silicon-based Tunneling FETs, the relatively large bandgap of silicon (~1.12 eV) limits the tunneling probability, resulting in lower current drive compared to traditional MOSFETs. This has led researchers to investigate alternative materials with smaller bandgaps, such as germanium or III-V compound semiconductors, to improve the on-current in Tunneling FETs [8].

In addition to exploring new materials, strain engineering has emerged as a powerful technique to enhance the performance of silicon-based Tunneling FETs by modifying their band structure. Strain, when applied to a semiconductor, alters the spacing between atoms in the crystal lattice, which in turn changes the energy levels of the conduction and valence bands. By applying tensile or compressive mechanical strain along specific crystallographic directions, the bandgap of the material can be reduced, enhancing the tunneling probability and increasing the on-current. Strain engineering has already been successfully employed in conventional MOSFETs to boost carrier mobility, and its application to TFETs has shown significant promise in overcoming the on-current limitation. This review article focuses on the role of strain engineering in enhancing BTBT in silicon-based Tunneling FETs, providing a comprehensive analysis of the theoretical underpinnings, experimental techniques, and future potential of this approach. First, we will delve into the fundamentals of band-to-band tunneling and its relevance in Tunneling FETs. Then, we will explore how mechanical strain can alter the band structure of semiconductors, improving tunneling efficiency. Finally, we will discuss experimental methods for applying and measuring strain in TFETs, and examine the future applications of strain-engineered devices in ultra-low-power logic circuits, the Internet of Things (IoT), and energy-efficient computing systems. By consolidating the latest research in this field, this review aims to shed light on the potential of strain-engineered Tunneling FETs to drive the next generation of semiconductor technology beyond the limitations of MOSFET scaling.





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Theoretical Foundations of Band-to-Band Tunneling

Quantum Mechanical Basis for Tunneling: The quantum mechanical basis for tunneling is fundamentally rooted in the principles of wave-particle duality and the probabilistic nature of quantum mechanics. Unlike classical physics, where a particle must possess sufficient energy to surmount a potential barrier, quantum mechanics allows for a different scenario. Particles, such as electrons, are described by wave functions that represent their probability distributions. When an electron encounters a potential barrier, there exists a non-zero probability that it can "tunnel" through the barrier, even if its energy is lower than the barrier height. This occurs because the wave function can extend into and even beyond the barrier, allowing the particle to emerge on the other side[5]. The WKB (Wentzel-Kramers-Brillouin) approximation provides a semi-classical method for analysing tunneling in quantum mechanics[9], [10]. It simplifies the calculation of tunneling probabilities by treating the wave function as an exponential function that decays within the barrier and grows outside of it. According to the WKB approximation, the probability of tunneling is exponentially related to the integral of the potential energy barrier along the tunneling path. Specifically, the tunneling probability T can be approximated as $T \sim e^{-2\gamma}$, where γ is determined by the width and height of the barrier. This method provides valuable insights into how factors such as barrier thickness and height affect tunneling likelihood. Overall, quantum tunneling, underpinned by wave function behavior and described by tools like the WKB approximation, plays a critical role in numerous phenomena, including Tunneling FETs flash memory devices, and nuclear fusion processes in stars, highlighting the profound implications of quantum mechanics in both natural and engineered systems.

Mechanisms and Applications of Band-to-Band Tunneling in Devices

Tunneling FETs: The Tunneling FETs architecture fundamentally differs from MOSFETs by utilizing quantum mechanical tunneling as the carrier transport mechanism. In an n-channel Tunneling FETs, for example, the source is heavily doped p-type, while the drain is n-type. A gate voltage modulates the tunneling probability across the source-channel junction. When a sufficient gate voltage is applied, electrons in the valence band of the source tunnel into the conduction band of the channel, bypassing thermionic emission over a barrier[11]. Band-to-band tunneling is a significant quantum mechanical phenomenon that allows charge carriers, such as electrons and holes, to transition directly between the valence and conduction bands of a semiconductor without needing to overcome a thermal energy barrier. This mechanism is particularly vital in the development of Tunneling FETs, which leverage BTBT to achieve low-voltage operation and high energy efficiency, making them ideal for ultra-low-power applications such as Internet of Things (IoT) devices and mobile technologies. The efficiency of BTBT can be enhanced by modifying the semiconductor's band structure through techniques like strain engineering, which alters the spacing between atoms in the crystal lattice, thereby adjusting the energy levels of the conduction and valence bands. This leads to increased tunneling probabilities, enhancing device performance. In addition to Tunneling FETs, BTBT is employed in various applications, including photodetectors, where it improves sensitivity and response times for infrared detection, and in non-volatile memory technologies like flash memory, enabling rapid data access and storage. Despite its advantages, BTBT faces challenges, particularly regarding lower on-current levels compared to conventional devices, which can limit performance in high-speed applications. Ongoing research aims to explore novel materials and device architectures, promising to unlock the full potential of BTBT in next-generation electronic systems.

TFETs offer several advantages over traditional MOSFETs:

- **Steep Subthreshold Slope:** Tunneling FETs can achieve a sub-threshold slope much steeper than the 60 mV/decade limit, resulting in lower power consumption[12].
- **Reduced Short-Channel Effects:** Because the transport is not thermally activated, Tunneling FETs are less susceptible to short-channel effects that degrade MOSFET performance[13].
- **Low Power Operation:** The lower required supply voltage makes Tunneling FETs ideal for energy-efficient logic circuits[14].

Despite these advantages, the main challenge for Tunneling FETs has been achieving high on-current. Since tunneling efficiency depends on the tunneling distance, which is set by the bandgap, materials with smaller bandgaps, like germanium or III-V compounds, are often used.



**Sukanta Swain****Impact of Mechanical Strain on Band Structure and Tunneling Efficiency**

Strain-Induced Modifications in Silicon: Mechanical strain has been widely adopted as a technique to enhance carrier mobility in semiconductor devices. For silicon-based devices, applying tensile or compressive strain can significantly alter the band structure by lifting the degeneracy of the conduction or valence bands. This alteration results in a modified density of states and effective carrier mass, both of which impact BTBT in Tunneling FETs. Strain applied along different crystallographic axes can modify the silicon bandgap. Tensile strain in the [100] direction, for example, reduces the bandgap, effectively narrowing the tunneling barrier and enhancing tunneling current [13]. On the other hand, compressive strain can increase the bandgap, reducing tunneling efficiency. Theoretical studies have shown that applying strain can reduce the effective mass of carriers, particularly for electrons in the conduction band, thereby enhancing tunneling current [14-18].

Theoretical Models of Strain Effects: The impact of mechanical strain on the electronic properties of silicon can be quantitatively described using models that account for the deformation potential theory. Additionally, full-band simulations combined with the WKB approximation are used to predict changes in tunneling probabilities. These models show that uniaxial stress can split the conduction band into different valleys, leading to an anisotropic effective mass. In strained silicon, the electron tunneling mass decreases along specific crystallographic directions, further enhancing the tunneling probability [16]. Experimental results confirm these predictions, showing that under tensile strain along the [110] direction, tunneling currents can increase by up to 15% in silicon-based TFET. This makes strain engineering an essential technique for improving the performance of BTBT devices [18].

Experimental Techniques for Strain Application in Silicon Devices

Fabrication of Strained-Silicon Devices: The fabrication of strained-silicon devices begins with the epitaxial growth of silicon on a relaxed silicon-germanium (SiGe) substrate. As silicon is grown on SiGe, lattice mismatch induces tensile strain in the silicon layer. This method has been used to produce high-mobility MOSFETs and Tunneling FETs [19]. In addition to epitaxial growth, strain can be applied post-fabrication using mechanical bending apparatuses. In these setups, the device is mechanically strained along a specific axis while current-voltage (I-V) measurements are performed to analyze the strain-induced changes in tunneling current [22].

Strained silicon on insulator (SSOI) technology represents a significant advancement in semiconductor materials, addressing the critical challenge of misfit dislocation-induced leakage currents prevalent in conventional strained silicon/silicon-germanium (Si/SiGe) structures as shown in fig 1(a) and (b). Langdo *et al* [23] Research group indicates that leakage mechanisms in bulk strained Si/SiGe devices are localized along misfit dislocation cores at the strained Si/SiGe interface, which enhance diffusion and contribute to leakage. However, the SSOI fabrication process effectively eliminates these dislocation cores, leaving only threading dislocation segments that do not induce leakage. Electrical characterization of fully depleted n-MOSFETs on SSOI substrates demonstrates substantial performance enhancements, including a 112% increase in electron mobility and nearly ideal subthreshold slopes of 66 mV/decade, closely matching those of devices on bulk strained Si substrates. Overall, SSOI technology offers an ideal platform for advancing high-performance silicon microelectronics, paving the way for innovations in computing and communications.

Strain Measurement and Characterization

Accurate measurement of strain in semiconductors is crucial for correlating experimental results with theoretical predictions. Common techniques include:

- X-ray Diffraction (XRD): Used to measure the lattice constant changes induced by strain.
- Raman Spectroscopy: Sensitive to strain-induced shifts in phonon frequencies, providing insights into the strain distribution in the material.
- Transmission Electron Microscopy (TEM): Used to visualize strain-induced dislocations at the atomic level.

These methods allow for precise quantification of strain, ensuring that its effects on the band structure and tunneling current can be reliably analyzed.





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Applications and Future Prospects

The potential applications for Tunneling FETs and other BTBT devices extend far beyond traditional logic circuits. In addition to low-power computing, Tunneling FETs are ideal candidates for:

- **Ultra-Low Power IoT Devices:** Tunneling FETs are well-suited for energy-constrained environments like the Internet of Things (IoT), where reducing power consumption is critical.
- **High-Speed Photodetectors:** BTBT devices have been explored as high-speed, low-noise photodetectors in optical communications.
- **Quantum Computing:** The low power dissipation and sharp switching characteristics of Tunneling FETs make them appealing for use in quantum computing architectures, where reducing heat generation is essential.

The integration of strain-engineered Tunneling FETs with advanced materials such as 2D materials (e.g., graphene, MoS₂) or III-V semiconductors holds promise for further reducing power consumption and improving tunneling efficiency. Future research will likely focus on optimizing strain conditions and exploring hybrid material systems for next-generation Tunneling FETs.

CONCLUSION

In conclusion, mechanical strain plays a pivotal role in enhancing band-to-band tunneling (BTBT) in silicon devices, offering a promising avenue for overcoming the limitations faced by traditional semiconductor technologies. By altering the crystal lattice structure and modifying the energy band alignment, strain engineering significantly increases the tunneling probability, thus improving the performance of devices such as Tunneling FETs. This enhancement not only enables lower operational voltages and reduced power consumption but also allows for greater scalability in device dimensions, aligning with the ongoing demands for miniaturization in electronics. As researchers continue to explore and refine strain engineering techniques, the integration of strained silicon in next-generation semiconductor devices holds the potential to drive advancements in ultra-low-power applications, high-speed computing, and emerging technologies like neuromorphic computing and flexible electronics. Ultimately, leveraging mechanical strain represents a critical strategy in pushing the boundaries of silicon-based devices, facilitating a new era of energy-efficient and high-performance electronic systems.

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An - In Depth Exploration of Recent Trends in Hospital Administration: Navigating the Future

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ABSTRACT

This abstract provides a succinct overview of the comprehensive review article on recent trends in hospital administration. The dynamic landscape of healthcare has witnessed transformative changes, and this review explores key developments shaping the future of hospital management. From the integration of digital technologies and health information systems to the emphasis on patient-centric care, the evolving role of data analytics, and the adoption of value-based care models, hospital administrators are navigating a complex terrain. The abstract encapsulates the essence of interdisciplinary collaboration, regulatory compliance, and the constant pursuit of innovation in the pursuit of high-quality, cost-effective and patient-centred healthcare delivery. As the healthcare sector continues to adapt, this abstract serves as a guide to the critical trends shaping the trajectory of hospital administration. The evolving healthcare landscape is characterized by a dynamic interplay of digital transformation, patient-centric care, data analytics, value-based models, interdisciplinary collaboration, and regulatory compliance. Hospitals and healthcare services need to focus and plan strategies based upon the requirement of the present medical service.

Keywords: Data analytics, Value-based care, Accreditation, Healthcare innovation, Cost containment, Resource allocation, Quality of care.





INTRODUCTION

Hospital Administration which is a dynamic field evolves constantly to meet the challenges of an ever-changing healthcare landscape. In the present years, several trends have developed, reshaping the way in which the hospitals are managed and healthcare is delivered. This review explores key development in administration of the hospital, which highlights their impact on efficiency, patient care, and overall healthcare outcomes. In the present realm of healthcare administration, the convergence of the data analytics and modelling prediction has emerged as a pivotal intersection, reshaping the landscapes of making the decision within the hospitals and healthcare systems. The modern healthcare demands for a planned approach for managing vast amount of data, and the application of the advanced analytics tools in combination with predictive modelling techniques has become instrumental in extracting actionable insights. Data analytics, as a fundamental discipline, involves the systematic exploration, interpretation, and visualization of these data sets. It empowers healthcare people to have a detail knowledge about the pattern, trends and correlations, fostering a data-driven culture that extends from clinical operations to administrative decision making. Predictive modeling shows a forward-looking dimensions

The huge and complex nature of the healthcare data, encompassing patients' records, the outcome of the treatment and operational parameters along with the sophisticated necessities which includes the data analytics, as a fundamental discipline, involves the systematic exploration, interpretation and visualization of these data sets. It increases the strength of the healthcare professionals to discern patterns, trends, and correlations, fostering a data driven culture that extends from clinical operations to administrative decision making. This sets stage for exploring the interconnected realms of data analytics and predictive modelling and the need for the understanding role in informed decision making within healthcare settings. As we deal into the subsequent Venn diagram, we will illuminate the shared space where data analytics and predictive modelling intersects, creating a symbiotic relationship that holds the implications for the strategic directions of healthcare institutions. Through this exploration we aim to unravel the transformative potential of these methodologies, illustrating their important role in shaping a more agile, adaptive and effective healthcare administration.

Digital Transformation and Health Information Technology:

The most significant trends in the hospital administration are the increasing reliance on advanced digital technologies and health information system, EHRs have become central to patient care, allowing for seamless data sharing among healthcare providers, reducing errors and enhancing overall efficiency [1]. Modelling predictive is also being employed to forecast patient admission rates, allowing hospitals to allocate resources more effectively.

Patient – Centric Care

Patient-centric care is strongly emphasized by the modern hospital administration [2]. Hospitals are increasingly focussing on improving the patients experience, from streamlined registration processes to personalized treatment plans. This not only improves patients' satisfaction but also contributes to better health outcome and increased patient loyalty.

Data Analytics and Predictive Modelling

In Hospital Administration the use of data analytics has become instrumental [3]. Healthcare providers are having big data to gain insights into patient's populations, optimize resources allocation, and identify trends that can inform strategic decision-making.

Cost containment and Value -Based Care

In view of the rising costs of the healthcare, hospital administrators are adopting value – based care models [2] These help to prioritize the quality of care over the quantity of services, incentivizing providers to focus on preventive measure and efficient resource utilization. This trend aims to improve patient's outcome while controlling healthcare costs.

Interdisciplinary collaborations

Effective hospital administration focusses the importance of interdisciplinary collaboration team – based care involving physicians, nurses, pharmacists and other health care professionals is becoming the norms [4].



**Jogi Naidu and Alana Teja****Regulatory compliance and Accreditation**

Adherence to regulatory standards and accreditation requirements is a growing focus in hospital administration. Meeting these standards not only ensures the delivery of high – quality care but also enhances the reputation of the hospital [4] . Administrators are investing in training and technology to maintain compliance with evolving health care regulation

DISCUSSION

The recent trends in hospital administration, as outlined in the review article, reflects a paradigm shift in healthcare management. The discussion below elaborates on the significance and implications of these trends

Digital transformation and health information technology

Significance: the integration of digital technologies including EHRs and telemedicine, streamline healthcare processes, enhances communication and improves patient outcomes.

Implications: Hospitals need robust IT infrastructure and staff training to fully leverage these technologies Privacy and security concerns must also be addressed

Patient centric care

Significance: Placing the patients at the centre of care improves satisfaction, fosters better communication, and contributes to positive health outcomes [5]

Implications: The patients experience should be prioritized first by the hospitals and should ensure that they involve the patients in decision making, and tailoring services to individual needs.

Interdisciplinary Collaboration

Significance: Adhere to regulators and accreditation standards ensures high -quality care and boosts the expertise of various healthcare professionals

Implications: hospitals need to foster a culture of collaboration, provide training on effective communication, and establish systems for interdisciplinary co-ordination.

Regulatory Compliance and Accreditation:

Significance: sticking to the regulations and standards accreditations ensures high- quality care and enhances the hospitals reputation.

Implications: Hospitals need to stay updated on upcoming regulations, invest in staff training, and implements systems for continuous quality improvement [1-3]

CONCLUSION

The latest developments in hospital management signify a revolutionary shift toward a healthcare environment that is more data-driven, patient-centric, and technologically sophisticated. The convergence of patient-centred care, data analysis, value-based models, interdisciplinary collaboration, digital transformation, and regulatory compliance represents a comprehensive approach to tackling issues and possibilities in contemporary healthcare management. Hospitals are better able to deliver seamless, individualized care as they make greater use of digital technologies and health information systems. The focus on patient-centricity not only improves the quality of treatment received overall but also helps to achieve better health results. Administrators are better equipped to make decisions when data analytics and predictive modelling are combined.





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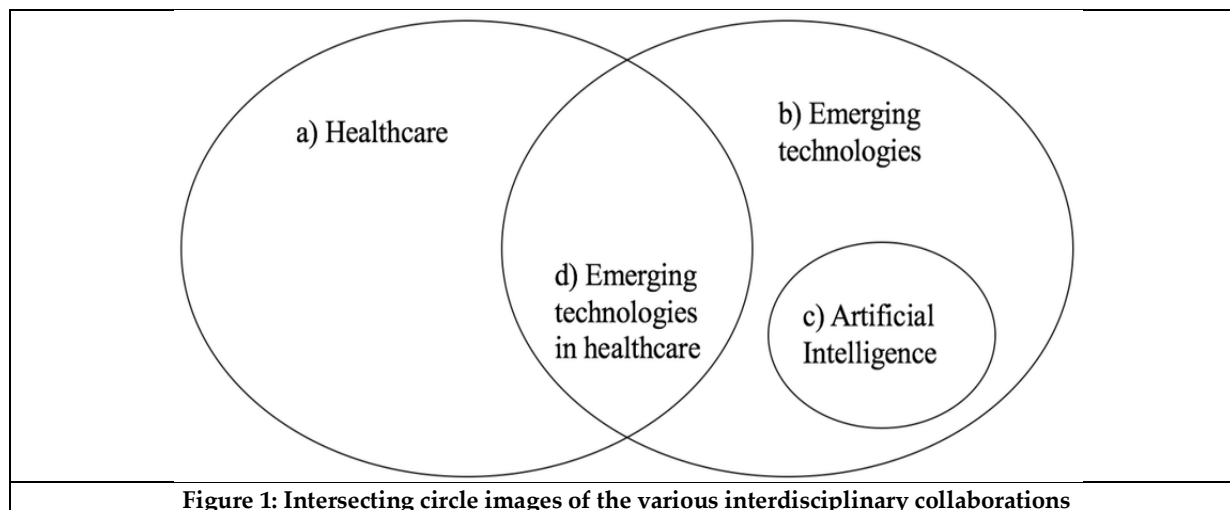


Figure 1: Intersecting circle images of the various interdisciplinary collaborations





MTSA Assisted Greener One Pot Synthesis of 2,4,6-Triarylpyridine Derivatives

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ABSTRACT

Melamine trisulfonic acid (MTSA) serves as a highly effective heterogeneous solid acid catalyst for several chemical reactions. A multitude of scientists have committed substantial efforts to utilizing MTSA as an eco-friendly catalyst in the synthesis of N- and O-containing heterocyclic molecules. Moreover, MTSA has been utilized for the safeguarding of alcohols, phenols, amines, aldehydes, and ketones, in addition to the acetylation of alcohols and phenols, and the N-formylation of amines. An efficient catalytic method has been developed for the synthesis of several Triarylpyridine derivatives. This approach comprises a one-pot three-component reaction, employing MTSA as an effective catalyst and ethyl alcohol as the solvent.

Keywords: Melamine trisulfonic acid (MTSA), Green one pot synthesis, Solid acid catalyst, Heterocyclic compounds.





INTRODUCTION

In recent decades, multi-component reactions (MCRs) have exhibited considerable efficacy and efficiency as bond-forming techniques in organic, combinatorial, and medicinal chemistry, especially in the context of green chemistry. Multi-component reactions (MCRs) demonstrate significant flexibility and display atom economy, as they advance through a sequence of reaction equilibria to yield the desired final product. The properties of the catalyst, together with various other reaction factors, significantly influence yield, selectivity, and overall applicability in a certain chemical process [1-6]. The quest for a cost-efficient, mild, reusable, and adaptable catalyst for multi-component reactions (MCRs) is a topic of significant interest. Catalysis has been essential in reducing pollution caused by chemical processes in our environment. The use of catalysts in organic reactions improves efficiency and selectivity, resulting in a decrease in substantial amounts of by-products and waste chemicals. Homogeneous acid catalysts, such as HF, HCl, CH₃COOH, HBr, CF₃COOH, and H₂SO₄, are widely utilized in various major industrial processes. Nonetheless, these catalysts exhibit certain disadvantages regarding their management, caustic properties, intricate processing protocols, and production of hazardous waste. Consequently, recent years have witnessed a substantial emphasis on the investigation of environmentally sustainable chemical processes or procedures. As a result, the exploration of heterogeneous catalysts for fine chemical synthesis has become a significant area of research. The potential advantages of these materials over homogeneous systems encompass increased handling efficiency, diminished corrosion-related challenges in reactors and plants, and superior environmentally sustainable waste disposal techniques.

Pyridine ring systems are a significant family of chemicals due to their theoretical relevance and their role as the structural framework for some alkaloids, anticancer agents, and antibiotics. Some pyridines are utilized in supramolecular chemistry owing to their stacking capability. These compounds have garnered significant attention in recent years due to their extensive pharmacological activities, including anti-malarial, vasodilatory, anesthetic, anticonvulsant, and antiepileptic properties, as well as their agrochemical applications, such as fungicidal, pesticidal, and herbicidal functions. The identification of novel MCRs is a compelling subject for researchers in synthetic chemistry. Consequently, as part of our ongoing efforts to establish an eco-friendly method for synthesizing heterocyclic compounds, we have attempted to synthesize chalcone derivatives using Claisen-Schmidt condensation, and we are presently undertaking another attempt to synthesize 2,4,6-Triarylpyridines (Figure 1) [11-13]. This paper aims to offer a succinct summary of recent developments in research concerning the various organic transformations enabled by MTSA, a heterogeneous and recyclable catalyst.

Experimental

MATERIALS AND METHODS

All chemicals utilized in this procedure are of analytical reagent quality, requiring no additional purification. The synthesized compounds were analyzed using ¹H-NMR (400 MHz) spectra acquired from a Bruker-Advance spectrophotometer in CDCl₃. FTIR spectra were obtained using a Bruker Alpha FT-IR with Opus version 6.1, while mass spectra were acquired on a Perkin-Elmer PESCIEX-API 2000, equipped with an ESI source utilized online with an HPLC system following the UV detector. XRD spectra were obtained using a PANalytical-Xpertpro diffractometer, and the average crystallite size was calculated from the associated XRD data. The microstructural morphology was examined using a JEOL-JSM 6610 LV scanning electron microscope (SEM). Magnetization measurements were conducted with a commercial vibrating sample magnetometer (VSM) model BHU-50 from Riken Denshi Co. Ltd., Japan.

General procedure for the synthesis of melamine trisulfonic acid (MTSA)

10 milliliters (150.4 m.mol) of chlorosulfonic acid was added to a 250 mL suction flask fitted with a gas intake tube to facilitate the passage of HCl gas over a solution that absorbs it, namely water. A total of 6.32 grams (equal to 50.14 m.mol) of Melamine was gradually added over a period of 30 minutes, while maintaining the ambient temperature.





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Hydrochloric acid gas was swiftly emitted from the reaction vessel. Subsequent to the incorporation of melamine, the mixture was subjected to rigorous agitation for 30 minutes. Subsequently, the residual hydrochloric acid (HCl) was eliminated using suction. The mixture was triturated with 20 ml of n-hexane and subsequently filtered. The solid residue was subjected to a washing process with n-hexane (20 ml) followed by drying in a desiccator. A total of 15.2 grams of Melamine trisulfonic acid, exhibiting 85% purity, was obtained as a solid white material [14].

General procedure for synthesis of 2,4,6-Triarylpyridines

A combination of Chalcone (1,3-diphenyl prop-2-ene-1-one, synthesized via the established Claisen-Schmidt condensation as detailed in our previously published paper, reference No. [23]) (10 mmol), urea (10 mmol), and nano Zinc Oxide catalyst (500 mg, pre-activated in a microwave oven for 2 minutes) was placed in a 50 ml round-bottom flask, to which 5 ml of ethanol was added as the solvent. The reaction mixture was refluxed at 80°C for 50 minutes. The reaction's progress was assessed using thin layer chromatography (n-Hexane, Ethyl acetate 3:1). The catalyst was recovered via filtration and subsequently washed with dichloromethane. The reaction mixture was concentrated using a rotary evaporator, and the solid product was subsequently recrystallized from hot ethanol many times to obtain a pure product. The associated products were validated using FT-IR, ¹H-NMR, and mass spectrum analysis (Table 1).

Spectral data of Triarylpyridine derivatives

2,4,6-triarylpyridine(3a): IR (KBr)cm⁻¹: 3011(Aromatic C=N Str), 1494, 1420(Aromatic C=C Str).¹H NMR (400 mHz, CDCl₃): δ 8.16- 8.37(m, 6H,Ar-H), 7.54-7.70(m,8H,Ar-H),7.26-7.41(m, 3H,Ar-H).ESI-MS m/z(%): 307 ([M+H]⁺ 100).

1-phenyl-3-(p-tolyl)prop-2-en-1-one(3b): IR (KBr)cm⁻¹: 3026(Aromatic C=N Str), 1486(Aromatic C=C Str).¹H NMR (400 mHz, CDCl₃): δ 8.13- 8.27(m, 6H,Ar-H), 7.56-7.72(m,8H,Ar-H) ,7.36-7.41(m, 2H,Ar-H), 2.36(m,3H,-CH₃).ESI-MS m/z(%): 321 ([M+H]⁺ 100).

3-(4-chlorophenyl)-1-phenylprop-2-en-1-one(3c): IR (KBr)cm⁻¹: 3023(Aromatic C=N Str), 1426(Aromatic C=C Str),726(-Cl Str). ¹H NMR (400 mHz, CDCl₃): δ 8.28- 8.36(m, 6H,Ar-H), 7.52-7.66(m,8H,Ar-H),7.26-7.38(m, 2H,Ar-H),.ESI-MS m/z(%): 341 ([M+H]⁺ 100).

3-(4-hydroxyphenyl)-1-phenylprop-2-en-1-one(3d): IR (KBr)cm⁻¹: 3216(-OH Str), 3021(Aromatic C=N Str), 1464, 1432(Aromatic C=C Str).¹H NMR (400 mHz, CDCl₃): δ 8.16- 8.37(m, 6H,Ar-H), 7.54-7.70(m,8H,Ar-H), 7.26-7.41(m, 2H,Ar-H), 5.35(m, 1H,-OH).ESI-MS m/z(%):323 ([M+H]⁺ 100).

3-(4-nitrophenyl)-1-phenylprop-2-en-1-one(3e): IR (KBr)cm⁻¹: 3011(Aromatic C=N Str), 1494, 1420(Aromatic C=C Str).¹H NMR (400 mHz, CDCl₃): δ 8.26- 8.47(m, 6H,Ar-H), 7.56-7.72(m,8H,Ar-H),7.19-7.31(m, 2H,Ar-H).ESI-MS m/z(%): 352 ([M+H]⁺ 100).

3-(4-bromophenyl)-1-phenylprop-2-en-1-one(3f): IR (KBr)cm⁻¹: 3017(Aromatic C=N Str), 1436, (Aromatic C=C Str),573(-Br Str).¹H NMR (400 mHz, CDCl₃): δ 8.26- 8.37(m, 6H,Ar-H), 7.56-7.71(m,8H,Ar-H),7.24-7.37(m, 2H,Ar-H).ESI-MS m/z(%): 385 ([M+H]⁺ 100).

3-(2-hydroxyphenyl)-1-phenylprop-2-en-1-one(3g): IR (KBr)cm⁻¹: 3227(-OH Str),3023(Aromatic C=N Str), 1494, 1426(Aromatic C=C Str).¹H NMR (400 mHz, CDCl₃): δ 8.16- 8.37(m, 6H,Ar-H), 7.54-7.70(m,7H,Ar-H),7.26-7.41(m, 3H,Ar-H), 5.35(m, 1H,-OH). ESI-MS m/z(%): 323 ([M+H]⁺ 100).

3-(2-nitrophenyl)-1-phenylprop-2-en-1-one(3h):IR (KBr)cm⁻¹: 3011(Aromatic C=N Str), 1494, 1420(Aromatic C=C Str).¹H NMR (400 mHz, CDCl₃): δ 8.23- 8.33(m, 6H,Ar-H), 7.46-7.55(m,7H,Ar-H),7.26-7.31(m, 3H,Ar-H).ESI-MS m/z(%):352 ([M+H]⁺ 100).

3-(2-chlorophenyl)-1-phenylprop-2-en-1-one(3i):IR (KBr)cm⁻¹: 3011(Aromatic C=N Str), 1494, 1420(Aromatic C=C Str), 726(-Cl Str).¹H NMR (400 mHz, CDCl₃): δ 8.16- 8.34(m, 6H,Ar-H), 7.44-7.60(m,7H,Ar-H),7.26-7.31(m, 3H,Ar-H). ESI-MS m/z(%): 341 ([M+H]⁺ 100).





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RESULTS AND DISCUSSION

Effect of loading of catalyst on the synthesis of 2,4,6-Triarylpyridines derivatives

The current reaction is observed with varying quantities of catalyst. The findings indicate that 500 mg of catalyst suffices to get a favorable product yield. Further increases in catalyst quantity will not result in a significant change in product yield. Consequently, 500 mg of catalyst was utilized to conduct the reaction. The findings are presented in Table 2.

Effect of solvent on synthesis of 2,4,6-Triarylpyridines derivatives

The investigation of the reaction medium indicated that solvents significantly influence the reaction. The findings are encapsulated in Table 3. Polar solvents, including acetic acid, CH₃CN, and C₂H₅OH, were shown to be significantly superior to non-polar solvents. Minimal yield detected when H₂O served as the solvent, perhaps attributable to the agglomeration of the hydrophobic catalyst. Despite the efficacy of CH₃COOH, a poor yield was achieved upon catalyst reuse; hence, we opted for C₂H₅OH as the solvent.

Effect of Temperature on Synthesis of 2,4,6-Triarylpyridines derivatives

The reaction temperature for the synthesis of 2,4,6-Triarylpyridine derivatives using the MTSA catalyst is 80°C, as shown in Table 4. It is noted that at temperatures below 80°C, the product yield is low and the reaction time is prolonged. We have verified that 80°C is an appropriate temperature for this reaction (Table 4).

Reusability of the catalyst

The reusability of the catalyst is a notable benefit that increases its efficacy in commercial applications. Consequently, an inquiry was undertaken into the recovery and reusability of MTSA. The reactive mixture was isolated using ethanol during these assays. The catalyst was effectively recycled through a filtration process after comprehensive washing with ethanol and subsequent drying at 60 °C. The catalyst was reusable for five cycles without any noticeable decline in its catalytic activity. The subsequent table, designated as Table 5, is provided for reference.

CONCLUSION

In conclusion, we have established an efficient method for synthesizing 2,4,6-Triarylpyridine derivatives utilizing chalcones and urea as substrates, with nano ZnO serving as an effective catalyst. Moreover, the current procedure yields substituted 2,4,6-Triarylpyridines in high yields. The use of MTSA as a catalyst has various advantages. The catalyst preparation process is uncomplicated. Furthermore, the catalyst necessitates less loading and facilitates ease of operation. Furthermore, it enables substantial yield without generating any by-products. Moreover, the catalyst may be easily recovered and reused, hence augmenting its applicability.

Declarations

Competing interests: There are no competing interests

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Table 1 synthesis of 2,4,6-triphenylpyridine derivatives

S.No.	Chalcone	R	Compound	Time (min)	Yield (%)
1	1,3-diphenylprop-2-en-1-one(3a)	H	2,4,6-triphenylpyridine	50	92
2	1-phenyl-3-(p-tolyl)prop-2-en-1-one(3b)	4-CH ₃	2,6-diphenyl-4-(p-tolyl)pyridine	55	92
3	3-(4-chlorophenyl)-1-phenylprop-2-en-1-one(3c)	4-Cl	4-(4-chlorophenyl)-2,6-diphenylpyridine	55	90
4	3-(4-hydroxyphenyl)-1-phenylprop-2-en-1-one(3d)	4-OH	4-(2,6-diphenylpyridin-4-yl)phenol	60	85
5	3-(4-nitrophenyl)-1-phenylprop-2-en-1-one(3e)	4-NO ₂	4-(4-nitrophenyl)-2,6-diphenylpyridine	60	85
6	3-(4-bromophenyl)-1-phenylprop-2-en-1-one(3f)	4-Br	4-(4-bromophenyl)-2,6-diphenylpyridine	55	90
7	3-(2-hydroxyphenyl)-1-phenylprop-2-en-1-one(3g)	2-OH	2-(2,6-diphenylpyridin-4-yl)phenol	60	85
8	3-(2-nitrophenyl)-1-	2-NO ₂	4-(2-nitrophenyl)-2,6-	60	85





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	phenylprop-2-en-1-one(3h)		diphenylpyridine		
9	3-(2-chlorophenyl)-1-phenylprop-2-en-1-one(3i)	2-Cl	4-(2-chlorophenyl)-2,6-diphenylpyridine	55	90

Table 2. Effect of catalyst loading on the formation of 2,4,6-Triarylpyridines derivatives

S.No.	Catalyst loading in (mg)	Time (min)	Yield (%)
1.	200	50	30
2.	300	50	50
3.	400	50	80
4.	500	50	92
5.	600	50	92

Table 3. Effect of solvent on synthesis of 2,4,6-Triarylpyridines derivatives

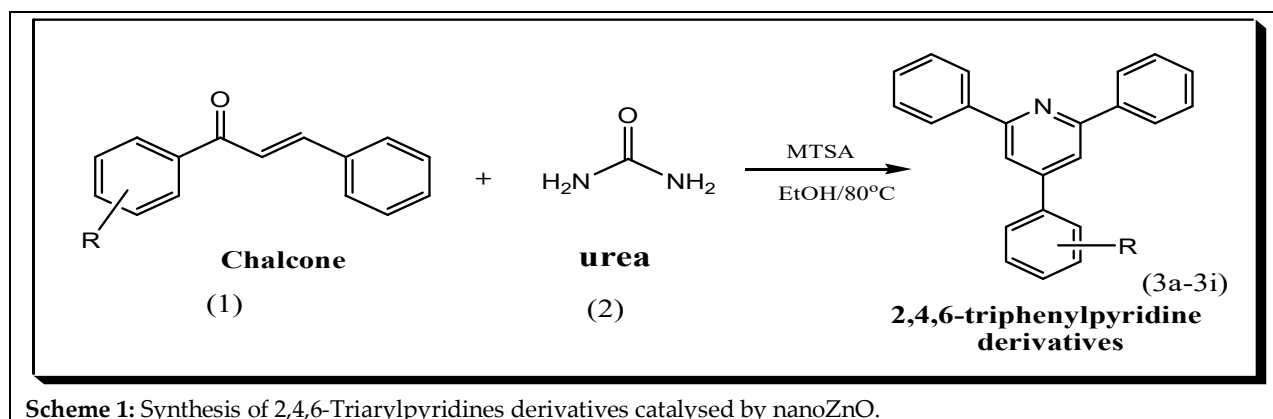
S. No.	Catalyst	Solvent	Time	Yield(%)
1	MTSA	H ₂ O	6hrs	traces
2	MTSA	CH ₂ Cl ₂	5 hrs	35
3	MTSA	CH ₃ COOH	240	50
4	MTSA	CH ₃ CN	90	60
5	MTSA	C ₂ H ₅ OH	50	92

Table 4. Effect of Temperature on the formation of 2,4,6-Triarylpyridines derivatives

S.No.	Catalyst	Temp(°C)	Time	Yield (%)
1	MTSA	R.T.	9h	20
2	MTSA	40	5h	50
3	MTSA	50	1.5h	60
4	MTSA	80	50 min	92

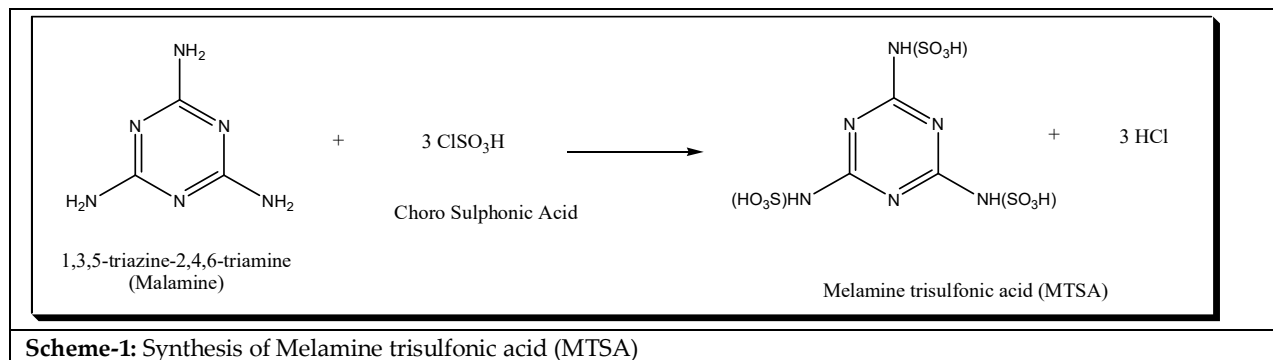
Table 5. Recyclability of the catalyst in synthesis of 2,4,6-Triarylpyridinesderivatives

Run no.	Yield (%)
1	92
2	90
3	88
4	86
5	85





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Home Automation using IoT Application

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ABSTRACT

Home automation has emerged as a promising field in IoT (Internet of Things), offering enhanced convenience, security, and energy efficiency to homeowners. This project focuses on implementing a scalable and cost-effective home automation system using Arduino Uno microcontroller boards and various sensors and actuators. The core idea revolves around creating a centralized control system that enables users to remotely monitor and manage their home appliances and devices through a user-friendly interface, such as a mobile application or a web dashboard. Arduino Uno serves as the central hub, connecting different IoT modules like sensors (e.g., temperature, motion) and actuators (e.g., relays for switching devices).

Keywords: Remote Control, Sensor Integration, Security Features, Energy Management.

INTRODUCTION

The project aims to demonstrate the feasibility and practicality of using Arduino Uno in a home automation context, highlighting its flexibility in integrating with diverse IoT components and its ability to provide a seamless user experience through intuitive controls. By leveraging Arduino's open-source platform, the system encourages further customization and expansion, making it adaptable to different household needs and technological advancements in IoT. Home automation has completely changed how we use our living areas in recent years by providing never-before-seen levels of security, convenience, and energy efficiency. By utilising technological breakthroughs in microcontrollers, such as Arduino, homeowners may now convert their homes into intelligent, automated homes. Renowned for its adaptability and simplicity, Arduino provides a strong platform on which to create complex home



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automation systems. Typically, these systems combine actuators to operate appliances, fans, and lights with sensors to monitor environmental parameters like humidity, temperature, and light levels.

The appeal of Arduino in home automation lies not only in its affordability and ease of use but also in its robust community support and compatibility with various communication protocols such as Wi-Fi, Bluetooth, and Zigbee. This allows for seamless integration with existing home networks and enables remote control and monitoring through smart phones, tablets, or computers. The objectives of this project are to design and implement a scalable home automation system using Arduino, demonstrating practical applications such as automated lighting, climate control, and energy management. By harnessing Arduino's capabilities, we aim to enhance user comfort, optimize energy consumption, and provide enhanced security through features like remote access and real-time monitoring. This introduction sets the stage for exploring how Arduino empowers individuals to create customized, intelligent environments that adapt to their lifestyles and preferences. As technology continues to evolve, so too will the possibilities for innovation in home automation, ensuring that homes of the future are smarter, safer, and more efficient than ever before.

Hardware Description

Arduino Uno can be used effectively to control various home appliances such as lights, fans, heaters, and more. Here's how you can interface Arduino Uno with these appliances:

Relay Modules

Description: Relays are essential for controlling high-power devices like home appliances since Arduino Uno's digital output pins cannot directly handle the high current or voltage requirements of these appliances.

Operation: A relay module typically consists of a relay (electromagnetic switch) and a driver circuit. When the Arduino sends a control signal (through a digital output pin), the relay switches on or off, allowing current to flow or interrupt to the connected appliance.

Connections: Attach the control signal to the relay module's input (often from an Arduino digital output pin). The relay module's output terminals are connected to the power supply lines (such as the live wire) of the appliance.

Coil: The relay coil is an electromagnet that, when energized, generates a magnetic field to activate the switch mechanism.

Switch Contacts: Relays have one or more pairs of switch contacts (normally open, normally closed, and common) that physically make or break electrical connections when the relay is activated.

Control Input (Coil Terminals): This is where you connect the control signal from Arduino (typically a digital output pin) to energize the relay coil.

Load Contacts (Output Terminals): These are the terminals where you connect the high-power circuit or appliance that you want to control (e.g., lights, fans, motors).

Types of Relays

Electromechanical Relays: These use an electromagnetic coil to mechanically operate the switch contacts. They are robust but may have slower switching times compared to solid-state relays.

Solid-State Relays (SSRs): SSRs use semiconductor switching elements (such as MOSFETs or TRIACs) to switch AC or DC loads electronically. They offer faster switching times, no mechanical wear, and silent operation.

Triac Modules (for AC appliances)

Description: Triac modules are used for controlling AC (alternating current) appliances directly from Arduino Uno.

Operation: Triacs can switch AC loads by controlling the gate signal. Arduino generates a control signal through a digital output pin, which triggers the gate of the triac to conduct or block the AC voltage.

Connections: Connect the AC appliance to the output terminals of the triac module. Ensure proper isolation and safety precautions when working with AC voltages.





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Power Supply

Description: Arduino Uno itself requires a stable DC power supply (typically 5V), which can be provided via USB or an external adapter.

Operation: External DC power adapters (7-12V) can be used to power both the Arduino and external components like relay modules.

Connections: Arduino's VIN pin or external power jack can accept the input voltage. The regulated 5V and 3.3V outputs from Arduino can power peripheral components and sensors.

Sensors (Optional)

Description: Sensors such as temperature sensors (e.g., DHT11, DS18B20), motion sensors (e.g., PIR sensor), light sensors, etc., can be integrated to add automation features based on environmental conditions.

Operation: Sensors provide input to Arduino's analog or digital input pins, allowing the system to react to changes in the environment (e.g., turning on lights when motion is detected).

User Interface (Optional)

Description: Arduino Uno can interface with various user interfaces like buttons, switches, or even mobile applications (using Bluetooth or Wi-Fi modules) for manual control or remote operation of appliances.

Operation: Buttons or switches connected to Arduino can trigger specific actions (e.g., toggling appliances). Mobile applications can send commands to Arduino via wireless communication modules.

Safety Considerations

Ensure proper isolation and protection against electrical hazards when working with high-power appliances and AC voltages. Use suitable enclosures and follow wiring standards to prevent short circuits and ensure reliability.

How Relays Work With Arduino UNO

Connecting to Arduino: Use a digital output pin on Arduino to control the relay. Typically, a relay module is used, which includes the relay itself and necessary driver circuitry. Connect the signal wire (often labelled "IN" or "SIG") of the relay module to a digital output pin on Arduino.

Power Supply: Ensure the relay module is powered appropriately (often 5V for Arduino-compatible modules). Some modules can also handle 3.3V logic levels.

Wiring to Appliances: Connect the high-power circuit or appliance to the output terminals of the relay module (often labeled "NO" for Normally Open, "NC" for Normally Closed, and "COM" for Common). The normally closed (NC) terminal and the common terminal are connected when the relay is not energised, allowing electricity to pass across the circuit. The circuit is broken when the relay is energised because the common terminal changes to the normally open (NO) terminal.

Programming Arduino: Use Arduino IDE to write a program (sketch) that controls the digital output pin connected to the relay module. You can toggle the relay on or off based on sensor inputs, timers, or user commands received via interfaces like buttons or mobile apps

Imagination & Design

In order to operate devices remotely or from a specific distance, we integrated sugar cube relays into the Arduino Wi-Fi module for this project. Here, we make use of hotspot setups. To accomplish our project's objective, we first establish a hotspot channel for connecting other devices. Next, in order for the other devices to connect, we must configure the correct IP address that the "Arduino uno" program generates. Keep in mind that the IP will remain constant since the module system is stable [5].

In this case, the circuitry of the sugar cube relay designs uses diodes to guard against the harm caused by back electromagnetic field (EMF) generated by the inner coil of the relay. As seen in figure 5, the capacitors are employed to stabilise the charge so that the coil remains in its established condition. The Arduino Integrated Development Environment (IDE) is a software that includes an editor for writing code, a message area, a text console, a toolbar



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with buttons for frequently used activities, and other menus. In order to upload and interact with programs, it connects to the Arduino and Genuino hardware. Programs written with the Arduino Software (IDE) are known as scratch programs. Text editors are used to produce these graphics, which are then saved with a file extension.

They are illustrated in Figure 6 combined with other Advance Computing tools for cutting, pasting, and finding and replacing text. Issues and feedback are displayed in the message box during exporting and saving. Text output from the Arduino Software (IDE) is shown on the console along with complete error messages and additional data. The configured board and serial port are visible in the lower-right area of the window. The toolbar buttons allow you to inspect and upload programs, generate, open, and save sketches, as well as access the serial monitor seen in figure 7. After a successful connection to the server, sensor data are sent to the web server for system monitoring. Figure 4 shows the web server page that will allow us to control and monitor the system. When the web browser enters the given IP address, this web server page will load. The web server offers information on the interior motion status and temperature in each room of the house. It also gives the status of several electrical equipment that may be controlled remotely, like lights and fans.

CONCLUSION

Arduino-based home automation systems represent a significant step towards creating smarter, more efficient, and secure living spaces. By empowering individuals to customize their environments according to their needs and preferences, Arduino fosters innovation in how we interact with and manage our homes. As technology continues to advance, the potential for Arduino in home automation remains vast, promising continued improvements in comfort, efficiency, and sustainability for homeowners worldwide

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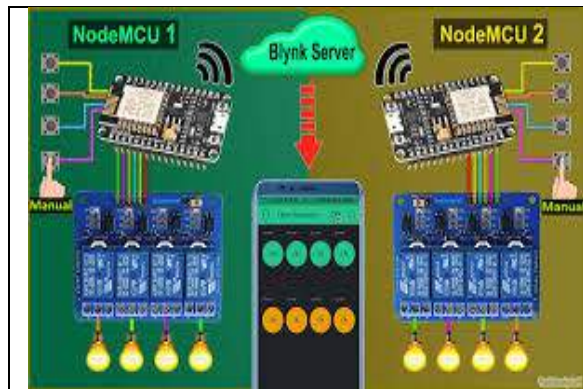


Fig1. Circuit Connections of Arduino Uno

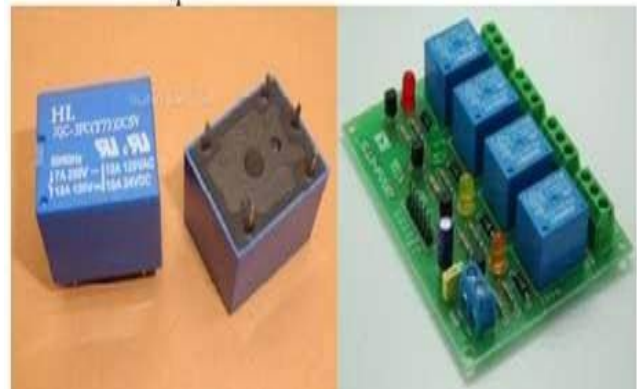


Fig 2. Varieties of Relays

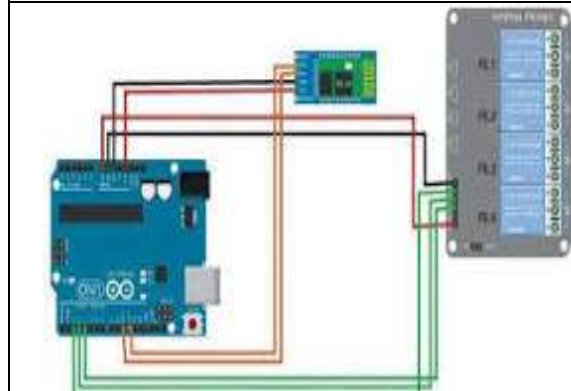


Fig3: Connection for Relay

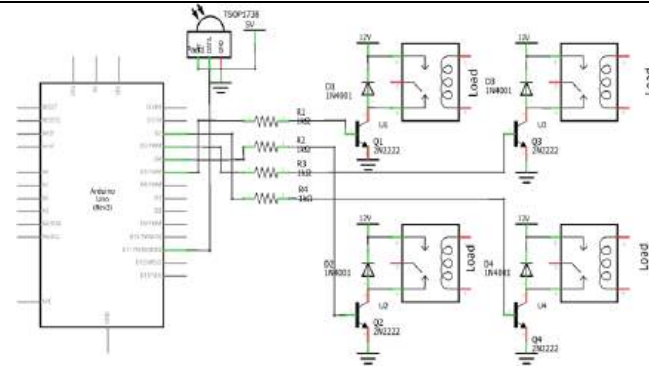


Fig5: General schematic diagram



Fig6. Software simulation on Arduino IDE



Fig 7: Project





Investigations on Cr (VI) Removal Hematite (α -Fe₂O₃) Nanoparticles Synthesized by a Facile Chemical Route

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ABSTRACT

Industrial wastewater poses a great threat to both plant and animal lives because of the presence of toxic and recalcitrant compounds. Heavy metals are one of them which have been proved biologically fatal for human if consumed above a trace amount. Chromium or Cr(VI) is one such heavy metal which is present primarily in tannery and electroplating effluents and is needed to be removed from the wastewater. Iron oxide nanomaterials can be used to remove Cr(VI) from industrial wastewater. In this study, the removal of Cr(VI) from synthetic solution using iron oxide nanoparticles is discussed. The α -Fe₂O₃ (hematite) nanoparticles were synthesized by chemical method and characterized using SEM, XRD, and FT-IR. The nanoparticles, having an average size distribution of 10-50 nm, were used in the removal of Cr(VI) from its single metal solution. The chromium removal study was carried out in batch mode by varying the contact time, initial Cr(VI) concentration, and adsorbent dose, and process temperature at neutral pH under continuous mechanical agitation. The percent removal efficiency of α -Fe₂O₃ nanoparticles at a



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dosage of 1 g/l was found out to be 82% and 90% at initial chromium ion concentration of 50 mg/l and 100 mg/l, respectively. The equilibrium time for both the cases was found out to be 40 minutes. Highest Cr(VI) removal was achieved at an α -Fe₂O₃ nanoparticle dose of 3.5 g/l for 50 mg/l Cr(VI) concentration. While for 100 mg/l Cr(VI) concentration, optimum α -Fe₂O₃ nanoparticle dose was 6 g/l. Also, the optimum process temperature was determined as 303 K.

Keywords: iron oxide nanoparticles; hematite; heavy metals; chromium; wastewater.

INTRODUCTION

The industrial waste water effluents contain mainly the various heavy metals, which are a real threat to the environment and public health, because their toxicity and persistence in the environment (Hu *et al.*, 2007). By means of bioconcentration, bioaccumulation, and biomagnification through biological chain and drinking water, human health will be threatened seriously by heavy metal ions. People have reported many times about the health issues that one faces when these heavy metals get into the human system. Rising demands for clean and safe water in extremely low levels of heavy metal ions make it greatly important to develop improved technologies for heavy metal ions removal (Xin *et al.*, 2012). And for this purpose, a great amount of research has been going on all around the globe to develop separation technologies which can efficiently remove these toxic and hazardous heavy metals from waste water. Hexavalent chromium [Cr(VI)] is a high-priority heavy metal pollutant in nature and found extensively in wastewaters from leather tanning, electroplating, pigment and chemical industry, metal processing, and mining of chrome ore (sometimes with concentration as high as 50,000 mg/l) (Kowalski, 1994). Its two main oxidation states are stable under environmental conditions: Cr(III) and Cr(VI). Cr(VI) is highly soluble and mobile in aqueous phase, thus exerting carcinogenicity and toxicity to biological systems (Cohen *et al.*, 1993). In the environment, Cr(VI) species may be in the form of dichromate (Cr₂O₇²⁻), hydrochromate (HCr₂O₇⁻), or chromate (CrO₄²⁻) in aqueous solution, depending on the pH (Park and Jang, 2002). Due to repulsive electrostatic repulsions, Cr(VI) anionic species are poorly adsorbed by negatively charged soil particles in the environment, and hence, they are transferred easily in aqueous environments. Cr(VI) also causes health problems such as liver damage, pulmonary congestions, vomiting, and severe diarrhea (Lvet *et al.*, 2011; Shi *et al.*, 2011). Due to the severe toxicity of Cr(VI), the EU Directive, WHO, and US EPA have set the maximum contaminant concentration of Cr(VI) in domestic water supplies as 0.05 mg/l (Selvi *et al.*, 2001).

There are many removal techniques such as adsorption, chemical precipitation, ion exchange, filtration, membrane separation, and reverse osmosis in order to diminish the pollution impact of these metals (Lo *et al.*, 2009). Unfortunately, these methods have several disadvantageous features such as expensive equipment requirement, continuous replenishment of chemicals, time consuming and easy to produce secondary pollution (like: sludge). Considering the limitations of conventional methods for metal ions removal, the most promising alternative method appears to be the optimal adsorption process. Over the years, many adsorbents have been developed, these including: activated carbon (both powdered and granular), zeolites, clays, pyrite fines, fly ash, and so on. In addition, adsorption is superior to other techniques for water reuse in terms of the initial cost, simplicity of design, ease of operation and insensitivity to toxic substances (Zhang and Banks, 2006). Despite these advantages, adsorption suffers from some drawbacks such as impurity, low adsorption efficiency, and slow kinetics. An ideal adsorbent should have a suitable particle size, accessible pores, large surface areas, and high stability. Therefore, in recent years, nanomaterials have attracted much interest. The most favorable route of Cr(VI) removal from water is by reduction to trivalent chromium [Cr(III)], which has low aqueous solubility and toxicity (Chang, 2005). Also, Cr(III) can be easily taken up by the negatively charged soil particles, effectively inhibiting their mobility in the aqueous environment (Kim *et al.*, 2012). Nanomaterials such as multi-walled carbon nanotubes (MWCNTs), nano-alumina, and titanium dioxidenanotubes have shown remarkable potential in Cr(VI) treatment (). However, precisely due to



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their high stability in the solution, the separation of nano-sized materials from the treated water is expensive and time-consuming. There are many types of nanomaterials with these characteristics, but magnetic iron oxide nanoparticles are an efficient adsorbent, which couples magnetic separation with ionic exchange capacity for removal of heavy metals pollutants (Wang *et al.*, 2009). Iron oxide nanoparticles are highly dispersible in solutions. With particle sizes of less than 40 nm, they offer a large surface area and superparamagnetic properties; they are attracted to a magnetic field but do not retain magnetic properties when the field is removed, making them highly useful in novel separation processes (Yantaseet *et al.*, 2007). At present, four major methods (co-precipitation, thermal decomposition, hydrothermal synthesis, and sol-gel method) were used to prepare iron-oxide nanoparticles. Generally, hematite nanoparticles are synthesized using hydrothermal and thermal decomposition method. But, such methods are both energy and cost intensive. Therefore, a facile chemical method for the synthesis of α -Fe₂O₃ nanoparticle is pertinent. Accordingly, in this paper presents a facile chemical method to synthesize α -Fe₂O₃ (hematite) nanoparticles at laboratory scale and their subsequent application in removing chromium (VI) from synthetic solution in a batch adsorption process.

MATERIALS AND METHODS

Materials

Ferric Chloride hexahydrate, Starch, 25% Ammonia solution, Triethylamine, Potassium Dichromate, Diphenylcarbazide, Acetone, Ethanol and other reagents purchased were of analytical grade. De-ionized Millipore water was used in synthesis and adsorption studies. All reagent solutions were freshly prepared and stored as instructed on the bottles.

Preparation of α -Fe₂O₃ nanoparticles

Synthesis of α -Fe₂O₃ nanoparticles by chemical precipitation method. Equal volumes of 0.25 M Ferric Chloride Hexahydrate (FeCl₃·6H₂O) and 0.5 M Starch solutions (in de-ionized water) were mixed to maintain their molar ratio of 1:2. The mixture was stirred for 30 minutes (Fig. 1). Triethylamine was added drop-wise to maintain the pH around 8-9. At this pH a brown colored colloidal precipitate of ferric hydroxide was obtained. The precipitate was collected by centrifuging at a speed of 5000 rpm and washed by thrice acetone and ethanol. Finally, it was dried in air oven at 70°C the dried sample was calcined at a temperature of 450°C, in a furnace for 5 hours. Chocolate brown iron oxide nano-powders were obtained. This iron oxide is of hematite, i.e., α -iron oxide, nature.

Preparation of Cr (VI) stock solution

A stock solution of 1000 mg/l of Cr(VI) ions was prepared using K₂Cr₂O₇ as the base salt. For this purpose, 2.826 g K₂Cr₂O₇ was added to 1000 ml of de-ionized Millipore water and the solution was stored in dark at room temperature. 5-7 ml of conc. sulfuric acid was added to the stock to maintain the stability of the Cr(VI) solution.

Material Analysis

The prepared α -Fe₂O₃ nanoparticles were characterized using X-ray Diffraction (XRD), Fourier transformed Infrared (FT-IR) spectroscopy, and Scanning Electron Microscopy (SEM). The amount of chromium (VI) was determined spectrophotometrically by Diphenylcarbazide method (Agarwal *et al.*, 2016) using SHIMADZU UV-VIS spectrophotometer at a wavelength of 540 nm. Initially, a standard curve was plotted for different known concentrations of Cr(VI) in standard solutions, which was later used to determine the concentration of Cr(VI) in the test samples after batch adsorption experiments. In both the cases de-ionized Millipore water was used as blank.

Chromium(VI) removal studies

Batch experiments were carried out using a conical-shaped bottle in an incubating shaker with an optimal shaking rate of 120 rpm at a uniform temperature of 30°C and a neutral pH. In a typical batch adsorption procedure, 1, 2, and 4 g/l concentration of prepared α -Fe₂O₃ nanoparticles were added to a 200 ml solution of K₂Cr₂O₇ corresponding to a Cr(VI) concentration of 50 mg/l and 100 mg/l. pH was adjustment was not performed. Temperature was varied



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between 293 K and 323 K. The mixture was kept in an orbital shaker at a constant speed of 120 rpm. Samples were collected from the bottle at regular time intervals of 10 min apart for 2 hours. The samples were filtered using Whatman® 0.45 μm filter paper and the filtrate was analyzed with the help of UV-VIS spectrophotometer at a wavelength of 540 nm to determine the amount of Cr(VI) present in it using diphenylcarbazide as the photo-indicator. All experiments were conducted in triplicate, and the results were averaged.

RESULTS AND DISCUSSIONS

Characterization of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles

The structural morphology was determined using SEM imaging method. The SEM analysis was performed using the JOEL 2010 Instrument, operated at 200 kV. Samples for SEM were prepared by evaporating dilute suspension on the glass slide and then the particles were collected on the carbon tape. Fig. 2 shows the SEM image of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles. The average nanoparticles size was found out to be 10-30 nm and the size distribution was around 18%. This size range was optimal for adsorption procedures. XRD patterns of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles were shown in the Fig. 3. The XRD patterns of the prepared samples were acquired with a Rigaku D-MAX 2200 X-ray diffractometer using Cu-K α radiation (40 kV, 300 mA) of wavelength 0.154 nm. The analysis was done using a 2-theta angle between 10 to 90 degrees. The typical diffraction peaks in XRD analysis at 24.6°, 32.7°, 41.2° and 54.6° verified the existence of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles in the analyzed sample. The sample showed a heightened peak at 34.8° which was evidence to the fact that the nanoparticles were of $\alpha\text{-Fe}_2\text{O}_3$ nature. The FT-IR spectra of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles revealed the predominance of Fe, O, and H, as illustrated in Fig. 4. A broad and extended bend between 3200 and 3600 cm^{-1} was the typical hydroxyl group, showing the presence of moisture in between the crystalline nanoparticles. A major peak at 792 cm^{-1} corresponds to the Fe-OH bending vibration. Whereas, another distinct peak at 1260 cm^{-1} represents Fe-OOH stretching vibrations. A peak at 698 cm^{-1} , corresponding to the stretching vibration of Fe-OH (Kamaraj *et al.* 2019).

Chromium(VI) removal studies

We have investigated the effect of contact time upon the removal efficiency of nanoparticles for fixed initial chromium concentrations and nanoparticles dosage as shown in Fig. 5. The initial chromium concentration was kept at 50 mg/l and 100 mg/l whereas the nanoparticles dosage was kept fixed at 1g/l. The experiments were conducted at neutral pH because the value of surface charge on hematite nanoparticles is 8.5 at the point of zero charge (pH_{pzc}) (Kosmulski, 2001). Below this value, the adsorbent surface was positively charged and the anions were adsorbed by electrostatic attraction. Above this value of pH_{pzc} , the adsorbent surface was negatively charged and the cations were adsorbed on the nanoparticles. Hexavalent chromium in wastewaters is present in forms as chromates (CrO_4^{2-}), dichromates ($\text{Cr}_2\text{O}_7^{2-}$) and bichromates (HCrO_4^-). And if we consider the increase in pH above its pH_{pzc} value, the uptake of Cr(VI) ions would decrease, because in the aqueous phase, the surface of the metal oxides was covered with hydroxyl groups that vary at different pH values. In these conditions, the OH^- groups from the mixture will compete with the chromium species for adsorptions sites. Also, if the adsorption surface is negatively charged, the electrostatic repulsions increase between negatively charged Cr(VI) species and negatively charged nanoparticles, leading to the removal of some adsorbed species such as bichromates (HCrO_4^-) or chromates (CrO_4^{2-}) (Hu *et al.*, 2005). The equilibrium contact time for the initial concentrations (50 mg/l and 100 mg/l) and dosage combination was found out to be 40 minutes because above this time the removal efficiency remained almost stable. It was found out that iron-oxide nanoparticles were able to remove around 82% of Cr(VI) from the solution when the initial concentration was 50 mg/l. When the initial concentration was 100 mg/l the removal efficiency increases to around 90%. This could be attributed to the fact that when the initial concentration was 100 mg/l the iron-oxide nanoparticles had more Cr^{6+} ions to adsorb onto their surface thereby increasing the removal effectively.

Fig. 6 presents the effect of initial Cr(VI) concentration on the Cr(VI) removal efficiency of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles from synthetic solution. A downward trend was observed with the rise in the initial Cr(VI) concentration in solution. The occupancy of all the available negative surface charge with Cr^{6+} ions and all the positive surface charges with



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HCrO_4^- or CrO_4^{2-} ions is the probable explanation for the observed trend. The reduction in the Cr(VI) removal efficiency was lower for a higher $\alpha\text{-Fe}_2\text{O}_3$ nanoparticle dose, compared to a lower adsorbent dosage. The complete Cr(VI) removal was achieved for 45 mg/l initial Cr(VI) concentration at 4 g/l $\alpha\text{-Fe}_2\text{O}_3$ nanoparticle loading. Fig. 7 demonstrates the effect of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles dose on the Cr(VI) removal efficiency from synthetic solution. For an initial Cr(VI) concentration of 50 mg/l, an increase in Cr(VI) adsorption was observed till a $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles dose of 3.5 g/l (around 97%). Beyond that almost a flat Cr(VI) uptake was recorded with an increase in $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles dose. However, for an initial Cr(VI) concentration of 100 mg/l, the adsorption efficiency (around 90%) was seen to increase till an adsorbent dose of 6 g/l. Above which the removal efficiency remained constant. The increase in the Cr(VI) removal efficiency with an increase in the adsorbent dose is due to a rise in the available surface charges, which assisted the adsorption process (Agarwal *et al.*, 2016). However, once Cr^{6+} ions are exhausted in the solution, and an equilibrium between the amount adsorbed and the amount remaining in the solution was reached, no enhancement in Cr(VI) uptake was possible, even with a higher adsorbent dose. Fig. 8 demonstrates the effect of process temperature on the Cr(VI) removal efficiency of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles. With an initial rise in the Cr(VI) uptake till a temperature of 303 K (around 99.5 %), a downward trend was observed beyond the temperature. 403 K was considered as the ambient process temperature. So, it can be inferred that above the ambient process temperature, the Cr(VI) removal efficiency by $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles take a dip. So, the optimum temperature for Cr(VI) adsorption by $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles is 303 K. Thus, the study presents a complete overview on the preparation of $\alpha\text{-Fe}_2\text{O}_3$ nanoparticles, their characterization, and utilization as an excellent adsorbent for Cr(VI) removal from synthetic solutions.

CONCLUSIONS

The $\alpha\text{-Fe}_2\text{O}_3$ (hematite) nanoparticles were synthesized using chemical precipitation method at laboratory scale. They were characterized (using SEM, XRD, and FT-IR) and the average sizes of nanoparticles were found as 10-30 nm. The nanoparticles were successfully tested in the removing Cr(VI) from its single metal-ion solution. The effect of contact time upon removal efficiency was investigated and the equilibrium time was determined. The equilibrium time for a dosage of 1 g/l of nanoparticles was found out as 40 minutes, above which the removal efficiency remained almost constant. For an initial Cr(VI) concentration of 50 mg/l the removal efficiency was 82% whereas, for an initial Cr(VI) concentration of 100 mg/l the removal efficiency was about 90%. The obtained data represents the preliminary result obtained for achieving a systematic study regarding the removal of Cr(VI) from wastewaters using the iron-oxide nanoparticles as adsorbents with high capacity of adsorption due to their high surface area. Determination of Cr(VI) adsorption kinetic, isotherm, and thermodynamic models as well as the continuous adsorption studies are further scopes in this research.

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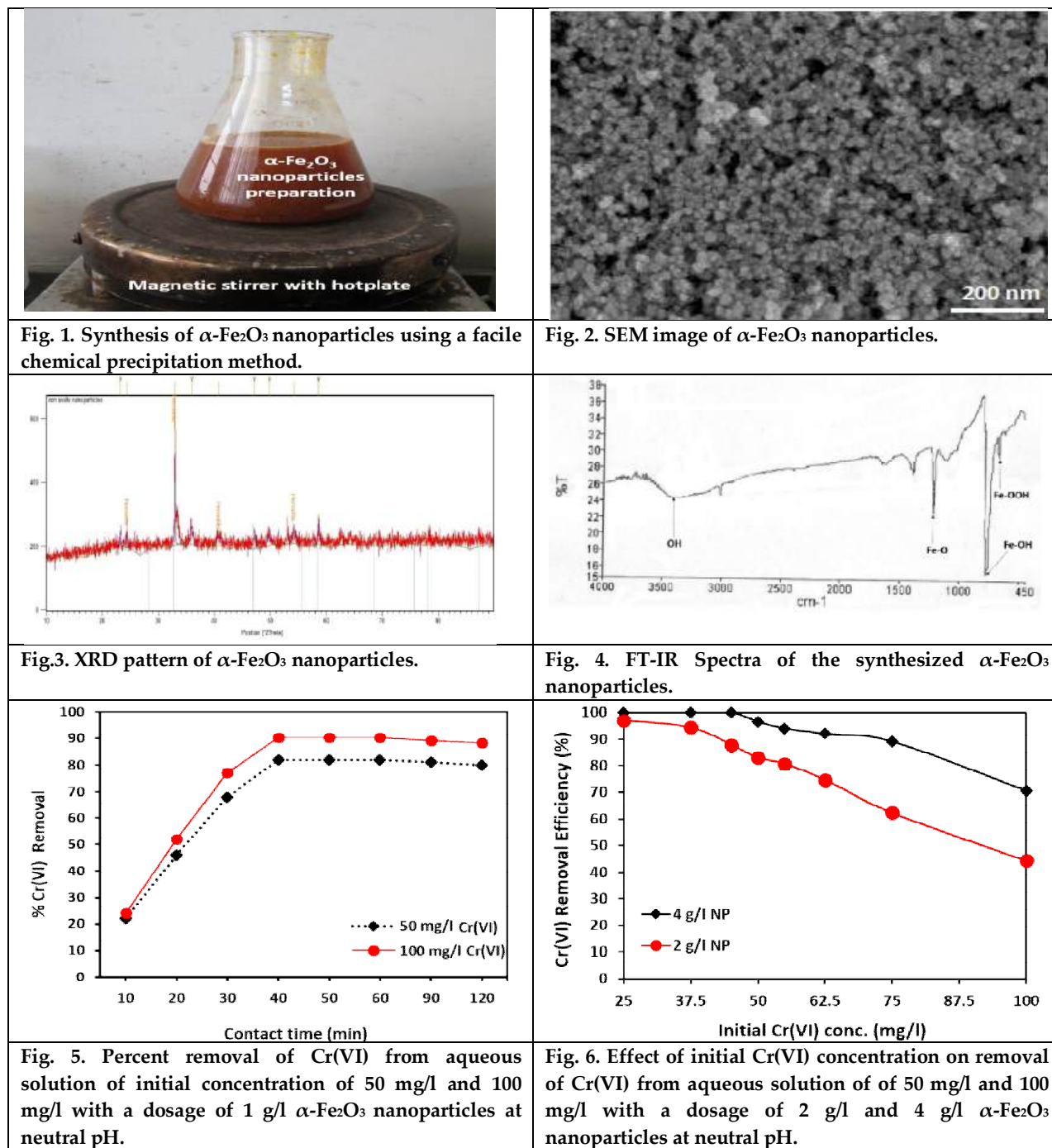
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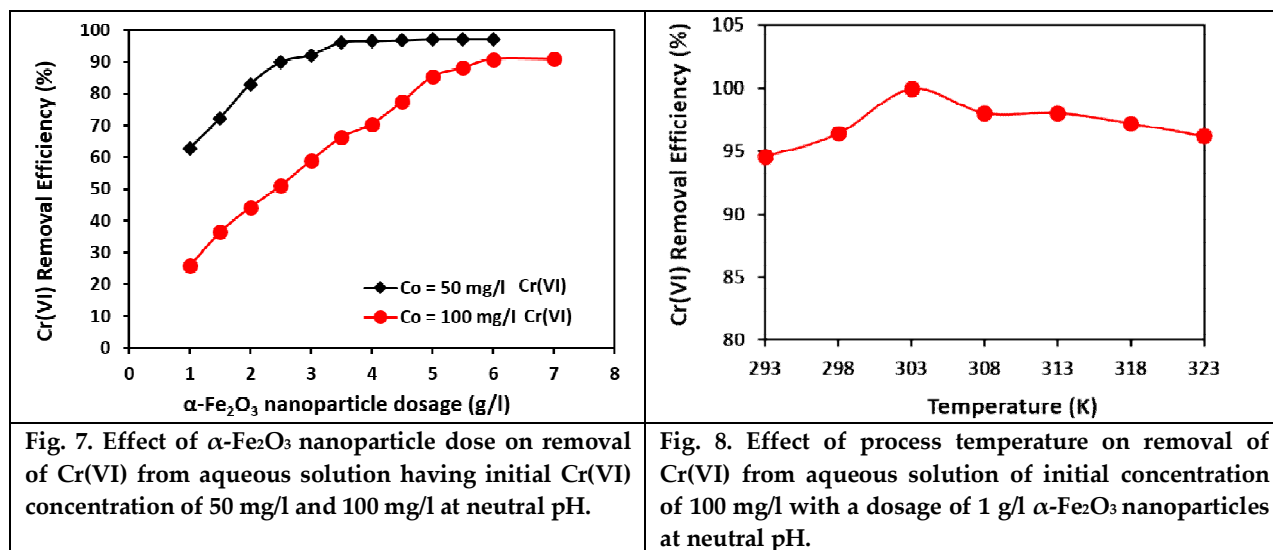
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The Function of Radiology in Forensic Science

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ABSTRACT

Forensic radiology, a key aspect of modern forensic science, involves the application of medical imaging in legal investigations. Techniques such as X-rays, CT scans, and MRI provide critical insights into trauma, cause of death, and other forensic issues. These imaging methods are instrumental in a variety of contexts, from identifying victims in mass disasters to aiding criminal investigations by revealing hidden injuries or foreign objects like bullets. In both post-mortem examinations and cases involving living individuals, forensic radiology helps pathologists and law enforcement uncover crucial evidence. Its non-invasive nature allows for thorough analysis without altering remains, preserving the integrity of the investigation. Additionally, radiographic evidence is often used in court to support findings with scientifically validated visual data, enhancing the reliability of testimony. This essay delves into the various roles that forensic radiography plays in ensuring justice and accuracy in medico-legal cases.

Keywords: postmortem imaging, trauma analysis, forensic radiology, imaging methods, forensic investigations, and legal evidence.

INTRODUCTION

Overview of Radiology in Forensic Science

Radiology has traditionally played a key role in medical diagnostics, but its application in forensic science has significantly expanded in recent decades. This growth is driven by the increasing need for non-invasive methods to





examine bodies, particularly in sensitive forensic cases. Radiological techniques offer a way to investigate internal structures without disturbing the body, providing crucial information for forensic analysis. This approach allows for detailed assessments in a variety of scenarios, including trauma evaluation, cause of death determination, and identifying foreign objects, all while preserving the integrity of the evidence[1,2]. Forensic radiography has emerged as a crucial element in death investigations, injury evaluations, and victim identification in large-scale catastrophes in recent times. By giving precise inside images of the body, it plays a vital role in identifying fractures, foreign objects, and other trauma-related evidence that may not be apparent from the outside. This method is especially helpful in cases where conventional autopsy are either not feasible or require augmentation. Forensic radiography also provides a non-invasive and effective way to identify victims in major disasters, facilitating a prompt and courteous identification process[3,4].

Significance of Radiology in Legal and Forensic Contexts

Pathologists and law enforcement can acquire insights that may not be possible through exterior examination alone thanks to forensic radiology, which offers pathologists and law enforcement clear, comprehensive images that indicate internal injuries, concealed trauma, and the presence of foreign objects. Because of its accuracy, it is a vital instrument in medico-legal investigations, helping to record evidence in a non-intrusive and trustworthy manner. These methods provide high-quality imagery, which can be quite useful in legal contexts since it provides concrete, visible proof that can be shown in court. The capacity to provide objective, scientifically verified data to support legal procedures raises the investigation's credibility and helps to ensure justice is served[5].

Data Sources and Case Studies:

Data for this paper came from published case studies in forensic radiography, with a focus on trauma cases, disaster victim identification, and instances containing foreign items such as sharp objects and bullets.[6]The analysis encompassed not only traditional radiography methods but also advanced imaging technologies like computed tomography (CT) and magnetic resonance imaging (MRI). Conventional radiography remains a foundational tool, providing straightforward yet valuable insights into bone fractures and certain types of trauma. However, the incorporation of more sophisticated imaging techniques, such as CT and MRI, has revolutionized forensic investigations. These cutting-edge methods allow for a more comprehensive examination, offering detailed cross-sectional views and three-dimensional reconstructions of the body. CT scans are particularly effective in visualizing complex bone structures and internal injuries, while MRI excels in revealing soft tissue damage and subtle abnormalities, further enhancing the depth and accuracy of forensic analyses.

Radiological Techniques Used

While there are several techniques used in forensic radiology, X-ray imaging is the main tool used to identify bone fractures and detect foreign objects like gunshots. In forensic investigations, X-rays are frequently regarded as the gold standard since they offer quick, easy, and non-invasive viewing of implanted objects in the body as well as bone injuries. This method is very useful for gunshot wound instances, where it's crucial to find bullets or pieces for forensic investigation as well as legal proceedings. Furthermore, X-rays are a vital diagnostic tool for comprehending trauma in both living and deceased humans because of their exceptional efficacy in detecting bone injury[7,8]. CT scans are extremely useful in trauma cases because they are perfect for creating finely detailed cross-sectional images of the body. With the use of these high-resolution photos, forensic specialists can investigate inside injuries with remarkable clarity, revealing details about complex damage that could be overlooked using more traditional techniques. The capacity of CT to produce three-dimensional reconstructions improves knowledge of the type and extent of injuries, facilitating accurate recording of damage to both soft tissue and bones. This degree of specificity is especially important for forensic investigations since precise visual evidence is required to reconstruct events and identify the source of damage.[9]. When lesions to the brain and soft tissues may not be obvious on X-rays or CT scans, MRI is particularly helpful in detecting them. MRI is an invaluable tool for finding subtle or complex injuries because, in contrast to other imaging modalities, it excels at obtaining comprehensive images of soft tissue structures, such as muscles, ligaments, and the brain. When internal organ or brain injuries is suspected but cannot be fully evaluated using conventional radiography techniques, this approach is especially useful. MRI is a vital tool in



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forensic investigations because it can see these fragile tissues without exposing the body to radiation, revealing important details that could otherwise go missed[10].

Ethical Considerations

Strict ethical guidelines are meticulously followed when handling human remains, including obtaining the necessary legal authorizations and upholding the dignity of the deceased. In forensic radiology, every examination of human remains requires proper permissions, ensuring that all procedures comply with legal and ethical standards. The studies referenced in this field have been conducted with approvals from forensic committees and relevant legal authorities, ensuring that the rights of both the deceased and their families are respected. These ethical considerations are fundamental in maintaining the integrity of forensic investigations and ensuring that the process is carried out with the utmost respect for human dignity[10].

RESULTS AND DISCUSSION

Forensic Applications of Radiology

Radiology provides unmatched support to forensic science by shedding light on death reasons, detecting diseases and injuries that may not be apparent from the outside, and guaranteeing correctness in court proceedings.

Identification of Injury - Injuries including fractures, contusions, and soft tissue damage that can be hidden or not immediately apparent during a routine autopsy are identified and recorded with the aid of radiological imaging. Determining whether the injuries were caused by accident or deliberate misconduct might be aided by identifying particular patterns of trauma.

Identification of Foreign Objects - X-rays and CT scans can show the trajectory and location of foreign objects (such as bullets or fragments) in situations of gunshot or stabbing wounds. These pictures are frequently essential to comprehending the incident's conditions.

Post-Death Imaging - The use of non-invasive postmortem imaging, particularly CT, has proven to be a beneficial addition to conventional autopsy. This technique is especially crucial in situations where cultural or religious prohibitions restrict how intrusive an autopsy may be.

Legal Implications and Evidence Presentation[11]

Due to the admissibility of radiological scan images in court, forensic radiography is essential to legal processes. Numerous well-known criminal cases have included radiological evidence to support the conclusions of forensic pathologists.

Expert Testimony: When called upon to testify in court, forensic radiologists typically explain their conclusions and offer interpretations of the images.

Case Study: Gunshot Wounds: CT scans were used to help pathologists identify the bullet trajectories and number of shootings in a case involving numerous gunshot wounds. This information was crucial in determining the case's legal outcome.

Advanced Techniques in Forensic Radiology[13]

The link between radiology and forensic science has been further strengthened by the development of improved imaging technology. Methods such as virtual autopsy and 3D CT reconstructions have shown to be useful in offering comprehensive insights into trauma and injury.

Virtual Autopsy: Virtual autopsies are a state-of-the-art technique that pathologists use to investigate interior damage without entering the body. It involves 3D reconstructions using CT images. This method works especially well in well-known situations or when conventional autopsy methods are impractical.

Forensic MRI : Because MRI can imaging soft tissues, it can be especially helpful in cases of hypoxia, drowning, and brain hemorrhages where traditional radiology would not be able to yield definitive results.[14,16]

Disaster Victim Identification (DVI)

In large-scale incidents like airline crashes or natural catastrophes, radiology has become essential for identifying victims. Postmortem imaging helps identify people when visual recognition is impossible by comparing skeletal structures and dental records with ante-mortem medical information[17,18].





CONCLUSION

As a key component of forensic science, forensic radiology now plays a major role in death investigations, crime scene investigation, and the collection of legal evidence. Forensic radiologists can identify disaster victims, find concealed injuries, and provide crucial evidence in court cases by using cutting-edge imaging techniques. The field of radiology in forensic science will probably grow as technology develops further, providing even more advanced instruments for non-invasive testing and legal help.

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The Role of Antioxidants in Enhancing the Quality and Stress Tolerance of Vegetable Crops

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ABSTRACT

Antioxidants are essential compounds that play a crucial role in protecting vegetable crops from oxidative stress, which can arise from various environmental factors such as drought, salinity, and extreme temperatures. The accumulation of reactive oxygen species (ROS) during these stress conditions can lead to significant cellular damage, affecting both crop yield and nutritional quality. This review delves into the diverse types of antioxidants present in vegetable crops, including enzymatic and non-enzymatic antioxidants, and examines their physiological functions and implications for crop resilience. We highlight the various agricultural practices that can enhance antioxidant levels, leading to improved stress tolerance and nutritional quality in vegetables. Furthermore, we discuss the potential benefits of integrating antioxidant-rich practices into vegetable production systems, emphasizing their significance for sustainable agriculture and food security in a changing climate. By enhancing our understanding of antioxidants and their roles, we can develop innovative strategies to improve the resilience and nutritional value of vegetable crops, contributing to the overall health of both ecosystems and human populations.

Keywords: Antioxidant, drought, salinity, stress, food security





INTRODUCTION

Vegetable crops are a cornerstone of human nutrition, supplying essential vitamins, minerals, and bioactive compounds that contribute to overall health. Among these bioactive compounds, antioxidants have gained significant attention due to their ability to combat oxidative stress, which is increasingly prevalent due to environmental factors such as climate change, urbanization, and agricultural practices. Reactive oxygen species (ROS), which include free radicals and other highly reactive molecules, can accumulate in plants under stress, leading to oxidative damage that affects cell membranes, proteins, and nucleic acids. This oxidative damage can impair plant growth, reduce yield, and compromise nutritional quality (Miller *et al.*, 2010). Understanding the role of antioxidants in vegetable crops is crucial for enhancing their resilience to environmental stresses and improving their nutritional quality. Antioxidants function as a protective mechanism, neutralizing ROS and thereby preventing cellular damage. This review aims to comprehensively explore the various types of antioxidants found in vegetable crops, their physiological roles, and practical approaches for enhancing their levels. By implementing strategies that increase antioxidant levels, we can improve crop resilience and quality, which are vital for ensuring food security and sustainable agricultural practices in the face of ongoing environmental challenges.

The Importance of Antioxidants in Crop Production

The increasing frequency of abiotic stresses—such as drought, high salinity, and temperature extremes—due to climate change poses significant challenges for agricultural production. As plants encounter these stresses, the balance between ROS production and antioxidant defense mechanisms becomes disrupted, leading to oxidative stress. This imbalance can trigger a cascade of negative effects, including reduced photosynthetic efficiency, impaired nutrient uptake, and altered metabolic pathways, ultimately affecting crop yield and quality.

Antioxidants play a vital role in mitigating these effects. By scavenging ROS, they help maintain cellular integrity and function, enabling plants to adapt and thrive under adverse conditions. Moreover, the accumulation of antioxidants can enhance the nutritional quality of crops, providing health benefits to consumers. For instance, many antioxidants, such as phenolic compounds and vitamins, are linked to reduced risks of chronic diseases, making their presence in vegetable crops particularly valuable.

Objectives of the Review

This review aims to achieve the following objectives:

Examine the types of antioxidants present in vegetable crops: We will categorize antioxidants into enzymatic and non-enzymatic types, detailing their mechanisms of action and roles in plant physiology.

Highlight the physiological roles of antioxidants: We will discuss how antioxidants contribute to mitigating oxidative stress, enhancing stress tolerance, and improving the nutritional quality of vegetable crops.

Explore agricultural practices for enhancing antioxidant levels: We will outline various strategies, including nutrient management, the use of biostimulants, genetic improvement, and sustainable agronomic practices, to increase antioxidant levels in crops.

Discuss implications for sustainable agriculture and food security: We will consider how integrating antioxidant-rich practices into vegetable production can contribute to resilience against climate change and promote food security.

By addressing these objectives, this review will provide a comprehensive understanding of the importance of antioxidants in vegetable crops and their potential to contribute to sustainable agricultural practices.

Types of Antioxidants in Vegetable Crops

Antioxidants can be broadly classified into two main categories: enzymatic and non-enzymatic antioxidants. Each category plays a crucial role in protecting plant cells from oxidative damage.

Enzymatic Antioxidants

Enzymatic antioxidants are proteins that catalyze specific reactions to convert ROS into less harmful substances. The key enzymatic antioxidants in plants include:





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Superoxide Dismutase (SOD): This enzyme catalyzes the dismutation of superoxide radicals into hydrogen peroxide and molecular oxygen. SOD is considered the first line of defense against oxidative stress, as it significantly reduces the levels of harmful superoxide radicals.

Catalase (CAT): Catalase further decomposes hydrogen peroxide into water and oxygen, preventing potential cellular damage that can result from excessive hydrogen peroxide accumulation.

Peroxidase (POX): Peroxidases participate in the reduction of hydrogen peroxide and play roles in various physiological processes, including cell signaling and stress response. They are also involved in the metabolism of phenolic compounds, which can further enhance antioxidant capacity (Huang *et al.*, 2020).

The effective action of these enzymatic antioxidants is critical for maintaining redox balance in plant cells and ensuring cellular health during stress conditions.

Non-Enzymatic Antioxidants

Non-enzymatic antioxidants consist of various low-molecular-weight compounds that directly scavenge free radicals. Important non-enzymatic antioxidants in vegetable crops include:

Ascorbic Acid (Vitamin C): As one of the most potent antioxidants, ascorbic acid not only scavenges free radicals but also regenerates other antioxidants. It plays a vital role in photosynthesis and enzyme regulation, contributing to overall plant health.

Glutathione: This tripeptide serves as a major antioxidant in plants, participating in detoxifying harmful compounds and maintaining cellular redox status. Glutathione levels can be influenced by environmental stressors and nutrient availability.

Phenolic Compounds: These secondary metabolites exhibit strong antioxidant properties and contribute to the flavor, color, and health benefits of vegetables. Phenolics can scavenge free radicals, chelate metal ions, and modulate various metabolic pathways (Zhang *et al.*, 2018). Their presence is often associated with health-promoting effects in human diets.

Physiological Roles of Antioxidants

Antioxidants play several critical roles in plant physiology, particularly in response to abiotic stresses.

Mitigation of Oxidative Stress

Plants often experience oxidative stress when subjected to adverse environmental conditions, such as drought, high salinity, and extreme temperatures. The increase in ROS can lead to cellular damage, lipid peroxidation, and disruption of metabolic processes. Antioxidants play a vital role in scavenging these reactive species, preventing oxidative damage, and ensuring the functionality of cellular components (Apel & Hirt, 2004). For instance, the application of antioxidant-rich substances can significantly reduce lipid peroxidation in stressed vegetable crops, thus preserving membrane integrity and function (Yuan *et al.*, 2019). This preservation is essential for maintaining cellular homeostasis and overall plant health.

Enhancing Stress Tolerance

Research has demonstrated a strong correlation between the accumulation of antioxidants and improved stress tolerance in vegetable crops. For example, in tomato plants (*Solanum lycopersicum*), increased levels of ascorbic acid under drought conditions are associated with enhanced physiological performance, including improved photosynthetic efficiency and water-use efficiency (Bhowmik *et al.*, 2018). Additionally, studies have shown that antioxidant-rich varieties of peppers (*Capsicum spp.*) exhibit greater resilience to salinity stress, underscoring the protective effects of antioxidants. This enhanced resilience can lead to better yield stability and quality under challenging growing conditions.

Improvement of Nutritional Quality

Beyond their protective roles, antioxidants also enhance the nutritional quality of vegetable crops. High levels of antioxidants, particularly phenolic compounds and vitamins, contribute to the health benefits of vegetables in human diets, including the reduction of chronic disease risk (Zhang *et al.*, 2018). For example, broccoli (*Brassica oleracea*) varieties with elevated levels of glucosinolates and flavonoids have demonstrated higher antioxidant



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capacities, which are linked to their health-promoting properties (Hwang *et al.*, 2021). Therefore, enhancing antioxidant levels in vegetables not only benefits the crops themselves but also has significant implications for human health.

Enhancing Antioxidant Levels in Vegetable Crops

Given the critical roles of antioxidants in plant health and resilience, various agricultural practices can be employed to enhance their levels in vegetable crops.

Nutrient Management

Optimizing nutrient supply, particularly micronutrients such as selenium, zinc, and magnesium, can enhance the antioxidant capacity of crops. For instance, selenium application has been shown to increase glutathione levels and other antioxidants in crops like spinach (*Spinacia oleracea*), thereby improving stress tolerance (Zhang *et al.*, 2018). Balanced fertilization can influence the biosynthesis of antioxidant compounds, contributing to overall plant health. Furthermore, understanding the specific nutrient requirements of different vegetable crops can lead to more targeted interventions, ultimately resulting in improved antioxidant levels and crop quality.

Use of Biostimulants

Biostimulants, including plant growth-promoting rhizobacteria (PGPR) and seaweed extracts, can stimulate the production of antioxidants in vegetable crops. Research indicates that the application of seaweed extracts can enhance the activity of SOD and CAT in lettuce (*Lactuca sativa*), improving overall plant health and stress resilience (Chaves *et al.*, 2020). These biostimulants promote physiological responses that lead to increased antioxidant synthesis and improved crop performance under stress conditions. Additionally, exploring the synergistic effects of different biostimulants may yield new strategies for enhancing antioxidant levels in various vegetable crops.

Genetic Improvement

Breeding programs focused on developing antioxidant-rich varieties can significantly enhance the nutritional quality and stress resilience of vegetable crops. Marker-assisted selection for traits associated with high antioxidant levels can expedite the development of varieties that are both resilient to stress and nutritionally beneficial (Bhowmik *et al.*, 2018). Genetic engineering approaches are also being explored to enhance the synthesis of specific antioxidants in crops, leading to improved nutritional profiles. By incorporating traits that promote antioxidant accumulation, breeders can contribute to the production of healthier and more resilient vegetable varieties.

Agronomic Practices

Practices such as crop rotation, intercropping, and cover cropping can enhance soil health and nutrient availability, ultimately leading to increased antioxidant levels in crops. These practices promote biodiversity and improve soil structure, enhancing root development and nutrient uptake. Furthermore, controlled environments such as greenhouses can mitigate stress factors, allowing plants to allocate more resources toward antioxidant production (Huang *et al.*, 2020). By optimizing growing conditions, farmers can enhance the resilience and quality of vegetable crops.

Environmental Stress Management

Managing environmental stresses is critical for enhancing antioxidant levels in vegetable crops. Techniques such as regulated deficit irrigation can induce mild stress conditions that stimulate the accumulation of antioxidants without compromising yield (Chaves *et al.*, 2020). Similarly, practices that minimize soil salinity and maintain optimal growing conditions can promote healthier plants with higher antioxidant levels. Implementing integrated pest management and reducing chemical inputs can also contribute to healthier ecosystems, supporting the natural antioxidant production processes in vegetable crops.



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CONCLUSION

Antioxidants play a pivotal role in enhancing the quality and stress tolerance of vegetable crops. By mitigating oxidative stress and improving resilience to environmental challenges, antioxidants significantly contribute to sustainable agricultural practices and food security. The strategic enhancement of antioxidant levels through nutrient management, biostimulants, genetic improvement, and agronomic practices offers promising avenues for improving crop quality and resilience. Future research should continue to explore the complexities of antioxidant interactions, their physiological roles, and their implications for vegetable production in the face of global climate challenges. Understanding the intricate relationships between antioxidants and plant health will enable us to develop more effective strategies for enhancing the resilience and nutritional value of vegetable crops, ultimately contributing to the well-being of both ecosystems and human populations. This review underscores the crucial role of antioxidants in vegetable crops, emphasizing their impact on stress tolerance and nutritional quality. Integrating strategies to enhance antioxidant levels can lead to more resilient crops, contributing to food security and sustainable agricultural practices. Further research will deepen our understanding of antioxidant functions and support the development of innovative agricultural practices that can adapt to changing environmental conditions.

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Comprehensive Analysis of Diabetic Retinopathy Using Machine Learning: Implementing Support Vector Machines (SVM), Random Forest, and K-Nearest Neighbors (KNN) Algorithms

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ABSTRACT

A precise diagnosis and early identification are vital for avoiding loss of sight in persons with diabetes, as retinal degeneration due to diabetes is one of the main causes of blindness. In particular, Support Vector Machines (SVM), Random Forest, and K-Nearest Neighbors (KNN) algorithms are used to provide a thorough examination of diabetic eye disease in this paper. In order to improve feature extraction for accurate classification, we preprocessed a collection of retinal pictures. Utilizing accuracy, sensitivity, and specificity, each strategy's quality was assessed. With regard to identifying diabetic retinopathy, the study demonstrates the benefits and drawbacks of various algorithms and offers information on their potential uses in clinical settings. As a result of our research, surgeons now have a reliable tool for controlling diabetic retinopathy: the integration of these algorithms into models can greatly increase accuracy in diagnosis.

Keywords: Machine Learning, SVM, KNN, Diagnosis.



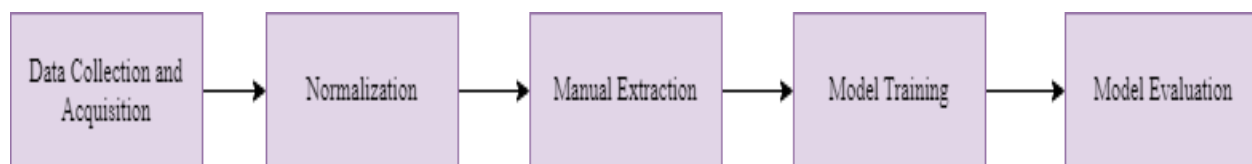


INTRODUCTION

The research emphasizes the different benefits and drawbacks of every method. One example of SVM's suitability for intricate retinal image categorization is its stability when working with high-dimensional data. It might, however, call for a lot of processing power. However, Random Forest's ensemble method offers a balanced approach, occasionally sacrificing interpretability in favor of high accuracy.[1] Although K-Nearest Neighbours is easier to use and more straightforward, it may not perform as well in real-time diagnosis when dealing with enormous data sets. Whenever diabetic retinopathy is not identified and treated promptly, it can cause irreversible retinal damage and even result in blindness. Worldwide diabetes prevalence is rising, making timely identification and close tracking of this condition essential. Automated techniques to aid in detecting diabetic retinopathy have been developed thanks to recent advances in algorithmic learning. K-nearest neighbors (KNN), Random Forest, and Support Vector Machines (SVM) have proven effective tools.[2] The usefulness of these computer algorithms in categorizing retinal pictures to identify diabetic retinopathy is investigated in this work. Approaches for prioritization are used to increase the classification's performance and functionality of the image. Indicators like accuracy, sensitivity, and specificity are used to assess each algorithm's effectiveness, providing important information about the algorithm's use in healthcare.[3] Healthcare providers may be able to determine retinopathy due to diabetes more accurately and consequently optimize the patient experience by including algorithms like these in detectable models. An extensive examination was carried out to guarantee these algorithms' dependability in clinical contexts. To evaluate an algorithm's capacity to accurately diagnose instances of diabetic retinopathy while reducing false positives and negatives, three critical metrics: accuracy, sensitivity, and specificity were examined.[4] To create a reliable diagnostic tool that physicians may use for early intervention, these parameters are essential.

METHODOLOGY AND DISCUSSION

The analysis of the intricate data related to diabetic retinopathy is made possible by machine learning (ML), which is essential for rapid and precise diagnosis. Structures and linkages in the evidence, which include the connection among retinal parameters like vessel area, exudate count, and retinal thickness, can be found and utilized for predicting the incidence of diabetic retinopathy by utilizing machine learning techniques. In clinical situations, where early care can stop progression of the condition and lower the chance of vision loss, this ability to anticipate is extremely significant.[5]



While training, numerous decision trees are constructed using the Random Forest collective learning technique, and the resulting results are combined to increase accuracy in predictions. By capturing the relationships between many features, including vessel_area, exudate_count, HbA1c_level, and others, it manages the complexity of the dataset. Random Forest lessens the possibility of aggregating projections of multiple trees, which can be especially helpful when handling the variation in characteristics like optic disc area in addition to the size of the retina amongst individuals.[6] SVM is a potent method for classifying that operates by identifying the outermost plane which most accurately divides the collected information and indicates several categories, the individuals either having or not having diabetic retinopathy in this case. It is well-known for handling either of the two types of classified issues, and it performs especially well in high-dimensional environments. Macular thickness, optic disc area, and ageing are examples of variables that SVM would use to determine the best bounds for this dataset to discriminate amongst one of the classifications (diabetic retinopathy = 0 or 1).[7] The data item can be classified using the KNN approach, which is straightforward but efficient, by looking at the vast majority of the class of its k-nearest neighbors in the



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domain of features. To categorize a patient in this case, KNN would compare the patient's retinal properties (such as vessel_area, hemorrhage_count, and diabetes_duration) with the characteristics of different individuals in that data set. Among the closest neighbors, the algorithm determines which class is most common, that is, whether diabetic retinopathy is present or absent.[8]

Background Work

One of the main causes of blindness, diabetic retinopathy, can be detected early thanks in large part to machine learning (ML). ML algorithms can detect minor indicators of retinal impairment that average clinicians might overlook by examining massive datasets comprising retinal photos. Patients with diabetes have a lower chance of developing eyesight loss when they receive early recognition and quick assistance, which can stop the disease's progression. In relation to the existence and degree of complications of diabetic retinopathy, retinal pictures are automatically classified using machine learning algorithms. By automating the process, ophthalmologists can screen more patients more rapidly and with less effort. Convolutional neural networks (CNNs) are one type of algorithm that performs very well at classifying images; it can diagnose images accurately and consistently without the need for human participation. Because ML can learn from large volumes of data, it improves the accuracy of diagnosis of diabetic retinopathy. Retinal picture patterns and aberrations that correspond to various disease phases can be identified by these models. Therefore, by reducing the possibility of misdiagnosis and producing more dependable outcomes than conventional diagnostic techniques, ML-driven technologies can perform better. Retinal pictures and patient data are analyzed using ML algorithms, which can assist in creating individualized therapy regimens. Based on the patient's unique risk factors and disease stage, these models can forecast how diabetic retinopathy will likely progress in each particular patient, allowing healthcare professionals to customize interventions. Treatment results and patient satisfaction are enhanced by this individualized approach. Although machine learning models are highly scalable, they can be implemented in a range of healthcare environments, including rural clinics and major hospitals.[9] This scalability guarantees that patients can obtain prompt and accurate diagnoses even in places with restricted access to specialized healthcare. Cloud-based machine learning models also improve accessibility by enabling remote analysis of retinal pictures, which benefits marginalized populations by providing a sophisticated diagnosis. When new data is added, machine learning models can continuously learn and get better. The models learn to accommodate novel patterns and uncommon situations when more visual signals are examined, growing in accuracy and resilience. As the population and illness characteristics change, this capacity for continual learning guarantees that ML-driven diagnostic systems continue to be useful. To give a complete picture of a patient's health, ML algorithms can be coupled with EHR platforms. Machine learning (ML) models can provide more accurate diagnoses and forecasts by integrating retinal image data with additional physiological data, such as blood sugar measurements and HbA1c. This can assist comprehensive patient care.[10,11,12]

CONCLUSION

The findings of this study suggest that the integration of machine learning algorithms into diagnostic models holds significant promise. By leveraging the strengths of SVM, Random Forest, and KNN, healthcare providers can enhance the precision of diabetic retinopathy detection, ultimately improving patient care and reducing the risk of blindness among individuals with diabetes.[13,14,15]

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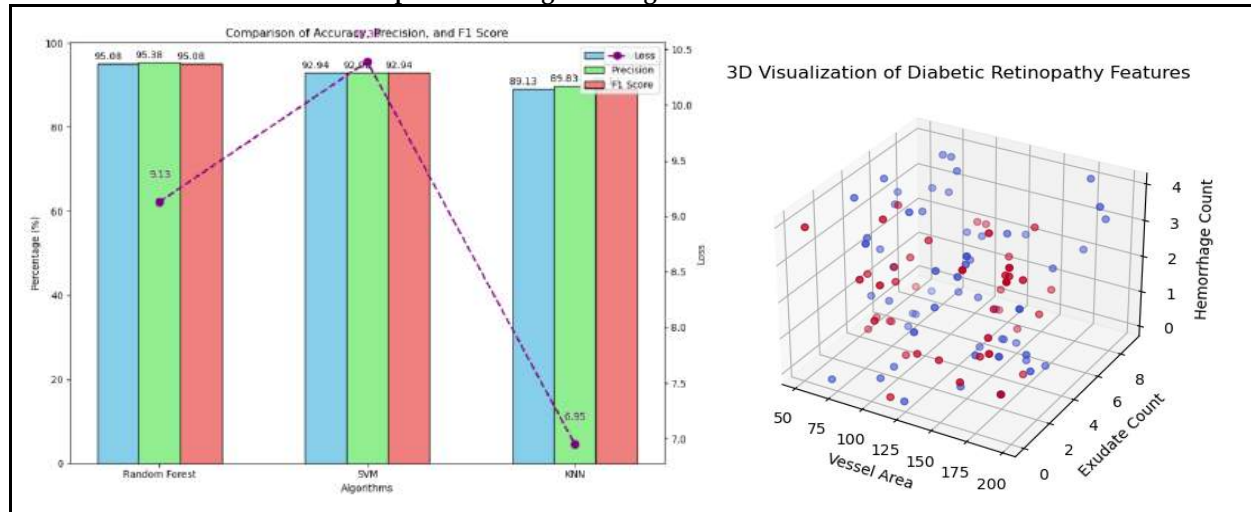
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RESULT ANALYSIS

Table 1: Experiment Results for Accuracy, Loss, Precision and F1 Score.

Algorithm	Accuracy	Loss	Precision	F1 Score
Random Forest	95.08	9.13	95.38	95.08
SVM	92.94	10.39	92.98	92.94
KNN	89.13	6.95	89.83	89.13



Sourajit Kumar Banerjee *et al.*,**Table 2 : Visualization of the Sample Data along with Algorithms Accuracies**



Cyber Vulnerability Assessment & Penetration Testing as a Security Technology

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ABSTRACT

We often hear in information systems that security is a journey rather than a destination. Every person in this modern society makes advantage of online facilities. One of the main internet's problems is security. Daily extremely competent hackers break through security and use weaknesses to get to the private information. One answer to this issue was proposed as Vulnerability Assessment and Penetration Testing (VAPT). The skill of vulnerability assessment is the opening door. Penetration testing is a sequence of events used to find and take advantage of security flaws. "Vulnerabilities are the gates allowing threats to be revealed". Vulnerabilities are literally defecting in systems. The security of the network is often guaranteed by penetration testing. Usually complicated, traditional penetration testing was manually carried out by tester following a scheme; so, it is labour-intensive and requires tester knowledge of all kinds of instruments. Therefore, it is highly desired to apply a consistent approach to explain the scheme which can be recognized by computer; subsequently, the computer may be utilized to replace tester to conduct penetration testing. The general VAPT overview as well as the Vulnerability Assessment and Penetration Testing process and techniques are presented in this work.

Keywords: VAPT, Penetration, Cyber Security, Information Technology



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INTRODUCTION

We often hear in information systems that security is a journey rather than a destination. That is true as, in security management of a network, we always have to try and keep one step ahead of our adversary: the crooks, disgruntled people, hackers, spies, miscreants. Without breaking any glass, they take data and information. One main goal of network security is data confidentiality. Every day opponents are perfecting their approaches to take advantage of network security and access the private data. These exploits attack availability of network resources, integrity, and secrecy. Confidentiality is somewhat similar to privacy. Measures of confidentiality are meant to stop attempts at illegal access to sensitive data. Data is often arranged based on the degree and kind of damage that would result from falling into the incorrect hands. Those categories therefore allow one to apply more or less strict policies in line with them (1). Integrity in data refers to keeping its consistency, accuracy, and dependability across its whole lifetime. Data cannot be modified in transit; so, measures must be implemented to guarantee that unauthorized persons—for instance, in a breach of confidence cannot change data. Availability of information refers to its regular and easily available nature for authorised persons. This entails correctly managing systems holding and displaying the information as well as hardware and technical infrastructure.

Vulnerability Assessment

In computer networks, systems, hardware, software, and other components of the IT ecosystem, vulnerability assessment is the process of finding vulnerabilities and dangers. Vulnerability assessments give security teams and other interested parties the tools they need to evaluate and rank risks for possible correction in the relevant setting. A key part of the vulnerability management and IT risk control cycles, vulnerability assessments assist guard systems and data from illegal access and data breaches. Usually using tools like vulnerability scanners, vulnerability assessments find weaknesses or risk exposures in the IT infrastructure of an entity (2). Vulnerability assessments let security teams employ a consistent, thorough, and unambiguous method to find and fix security risks and concerns. An organization gains from this in various ways: Early and constant recognition of IT security's shortcomings and hazards, Corrective measures to fix any holes and guard private systems and data, guard against data leaks and other illegal access.

Various Steps for Conduct a Vulnerability Assessment

With the right tools in hand, you can perform a vulnerability assessment by working through the following steps: First, you have to choose what you wish to scan a decision not always as straightforward as it sounds. Lack of awareness of their digital infrastructure and related devices is one of the most often occurring cyber security issues confronting companies. Several causes of this include: Devices such as laptops and smartphones are designed to periodically disconnect and reconnect from the workplace, employee homes, and other distant locations (3). IoT Devices: Despite being a part of the corporate infrastructure, mobile networks may be the primary means of connection for IoT devices. Cloud-Based Infrastructure: Simple, non-IT-dependent server spinning up on demand is made possible by cloud service providers. Though the reality is typically messier, we all want to work for a company with an immaculate organization. Simply tracking what several teams are posting online or modifying at any one moment can be challenging. This lack of visibility is troublesome since it makes it impossible to protect what you cannot see. Fortunately, this process's discovery component can be essentially automated. Some contemporary vulnerability assessment tools can examine public-facing systems and directly connect to cloud providers to identify cloud-based infrastructure. After determining your assets, the subsequent concern is whether you can financially sustain a vulnerability assessment for each component. Ideal scenarios would necessitate the regular execution of vulnerability assessments on each of your systems. However, since vendors sometimes charge per asset, prioritizing might help where budgets cannot cover every asset the business possesses. Among the several areas you might choose to give top priority are those involving Internet-facing servers, customer-facing apps, sensitive data contained in databases (4).



**Naga Jogayya Kothakota et al.,****Vulnerability Scanning**

Designed to find known security flaws and offer direction on their fixing, vulnerability scanners Since these flaws are often made public, a lot of information on susceptible programs is readily available. This data is used by vulnerability scanners to find weak devices and software within the infrastructure of a company (5). First, the scanner probes machines to find out about operating services, open ports, software versions, and configuration settings. Usually, the scanner can identify multiple known vulnerabilities in the system it is testing thanks to this data. Moreover, specific probes are sent by the scanner to identify vulnerabilities that can only be tested with a secure exploit that verifies the vulnerability's presence. Typical vulnerabilities such as "Command Injection," "cross-site scripting (XSS)," or the system's usage of default users and passwords could be discovered by these types of probes. Depending on the infrastructure you are scanning (and particularly how big any websites are), the vulnerability scan could take a few minutes to many hours.

RESULT ANALYSIS & REMEDIATION

The vulnerability scanner generates an assessment report whenever it finishes. Reading and creating remedial strategies based on this report should take this into account: A vulnerability scanner should mark a possible vulnerability depending on its degree. Prioritize the most serious vulnerabilities while making remediation plans, but never completely disregard the others. Many times, hackers chain numerous minor flaws to develop an exploit (6). A decent vulnerability scanner would propose deadlines for fixing every problem. Vulnerability Visibility: Although not all vulnerabilities exist on publicly accessible systems, it is essential to recall the aforementioned prioritization. Given that random hackers surfing the internet are more inclined to exploit internet-facing systems, these systems warrant greater attention for remediation. Employees possessing laptops with insecure software installed should be prioritized. Moreover, any systems that could adversely affect your organization or residence, particularly sensitive information, should be prioritized above others.

Continuous Cyber Security

A vulnerability scan is a process that offers a snapshot of the vulnerabilities that are currently present in the digital infrastructure of an organization at a particular point in time. New installations, configuration changes, newly identified vulnerabilities, and other things can quickly render the company exposed again. Nevertheless, the organization can be made vulnerable again. This is why vulnerability management should be an ongoing endeavor rather than a singular exercise. Contemporary software development businesses integrate automated vulnerability assessments into their continuous integration and deployment (CI/CD) pipelines. This is due to the fact that the creation of software results in the introduction of a significant number of vulnerabilities. They are able to identify and address vulnerabilities before the program is deployed, so preventing the possibility of exploitation and the requirement to produce and ship patches for vulnerable code (7). This allows them to avoid the potential for abuse.

Life cycle of VAPT

A penetration test—also called a pen test is a simulated cyberattack against your computer system meant to find exploitable weaknesses. Penetration testing is often employed in the framework of online application security to enhance a web application firewall (WAF). Pen testing can entail the attempted breaching of any number of application systems, (e.g., application protocol interfaces (APIs), frontend/backend servers) to find vulnerabilities (8). There five phases to the pen testing process. It is for this reason that vulnerability management ought to be an ongoing endeavor rather than a one-time exercise. There is a growing trend among modern software development companies to incorporate automated vulnerability assessments into their continuous integration and deployment (CI/CD) pipelines. The next stage is to determine how the target application will respond to various attempts to break in. This is accomplished through the process of scanning. In most cases, this takes place with: When a program is running, static analysis examines its code in order to make educated guesses about how it operates. When using these tools, it is possible to scan the entire code at the same time (9). Monitoring the code of an application while it is in operation is what is meant by the term "dynamic analysis." For the purpose of checking, this is a more effective





method because it demonstrates how an application is operating in real time. Acquiring Access to: Backdoors, cross-site scripting, and SQL injection are some examples of web application hacks that are utilized at this stage in order to locate vulnerabilities in the defenses of a target. Then, in order to determine the extent of the damage that can be caused by these vulnerabilities, testers attempt to exploit them by engaging in activities such as getting more permissions, stealing data, intercepting traffic, and so on. Maintaining Access: This stage takes a look at whether or not the vulnerability may be used to remain in the system that has been hacked for an extended period of time, which is sufficient for a malicious individual to get complete access. This is done with the intention of imitating sophisticated persistent attacks, which are able to remain in a system for months at a time and steal the most sensitive information from a business. Following the completion of the penetration test, the results are compiled into a report. This report includes a list of the exact vulnerabilities that were exploited, the sensitive data that was viewed, and the length of time that the pen tester was able to remain in the system without being discovered.

Vulnerability Assessment & Penetration Testing Techniques

Vulnerability Assessment Technique

During the process of static analysis, we do not carry out any test cases or exploits during the analysis. Both the structure of the code and the contents of the system are analyzed by us. It is possible for us to discover any and all types of vulnerabilities by utilizing this method. Because this method does not involve exploiting the system, there would be no negative impact on the system as a result of this testing session. This method is quite sluggish and requires a significant number of man-hours to complete, which is one of the most significant drawbacks of the methodology. Manual testing is a method that does not require the use of any tools or software in order to identify potentially exploitable flaws. The tester will make use of his own knowledge and experience in order to identify the vulnerabilities that are present in the system. Either a pre-prepared test strategy, known as systematic manual testing, or an exploratory manual testing approach, known as exploratory manual testing, can be utilized to carry out this testing. Because we do not need to purchase any vulnerability assessment tool for this technique, the cost of this technique is lower in comparison to the cost of other procedures (10). During the automated testing technique, we make use of automated vulnerability testing technologies in order to identify any flaws that may exist within the information system. Each and every test case is carried out by these tools in order to identify vulnerabilities. This results in a reduction in the number of man-hours and the amount of time needed to carry out testing. Because of the technology, it is also possible to undertake repeated testing in a very simple manner. The accuracy that is provided by automated testing is superior to that which is provided by other methods. The amount of time required is really low, and the same test cases can be utilized for subsequent procedures. But the cost of testing is increased by tools. There are many different kinds of vulnerabilities, and a single tool cannot discover all of them. Therefore, the overall cost of carrying out vulnerability assessment raises as a result of this. Testing using fuzzing is another name for this type of testing. During this process, we introduce invalid or random data into the system, and then we search for instances of failure and crashes. We can compare this to testing for robustness. This method can be implemented with a minimal amount of interaction from human beings. Identifying zero-day vulnerabilities is possible through the utilization of this method.

Penetration Testing Techniques

Testing using a black box involves the tester not having any prior knowledge of the network architecture or systems of the testing network. This technique is also known as "black box testing." Typically, black box testing is carried out from an external network to an internal network of the organization. Tester is required to make use of his knowledge and abilities in order to carry out this testing. In the testing method known as "grey box testing," the tester is only provided with a very limited understanding of the testing network. Despite the fact that the tester does not have a comprehensive understanding of network architecture, he is familiar with some fundamental information on testing network and system settings. In point of fact, grey box testing is a hybrid approach that combines both different testing methods. Either an internal or an external network can be used to carry out this task. White box testing is a type of testing in which the tester is fully aware of the system configuration of the testing network as well as the network configuration of the testing network. In most cases, this testing is carried out from within the organization's





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own network. Better results can be achieved by white box testing, which needs a comprehensive understanding of the system or network being tested.

Vulnerability Assessment and Penetration Testing Tools

Metasploit: An open-source framework for penetration testing that may be downloaded for free or purchased in a premium Pro edition that comes with professional support. Windows, Windows Server, RHEL, and Ubuntu are all supported for installation.

Nmap Zenmap: is a free network vulnerability scanner that also includes a front-end user interface. Windows, Linux, BSD Unix, and Mac OS are all supported by both of these.

Wireshark: A widely used packet sniffer that may be used for both wired and wireless nets. Suitable for installation on Mac OS, Linux, Unix, and Windows.

Assaulter John Ripper Cracker for passwords and hash type detector that is open-source and free to use. Installations are available for OpenVMS, Unix, macOS, Windows, DOS, and BeOS.

The Nessus Application: vulnerability assessor is offered in both a free and a premium edition. Windows, Windows Server, Linux, Mac OS, and Free BSD are all supported by the installation.

There is a crack. A well-known packet sniffer for wireless networks that is being utilized by hackers on a large scale. Linux is the operating system.

Suite of Burps: An environment for evaluating the vulnerabilities of web applications. is compatible with Linux. Inquiry into A vulnerability scanner for web applications that is designed to be utilized whenever the application is being developed.

VAPT Security Technology

Here, we'll show how vulnerability analysis fits the bill as a cyber-security tool. It is common practice for attackers to conduct reconnaissance on victim networks in order to learn more about them. After the attacker has collected enough information, they will scan the victim's system or network for security holes and compile a list of them. An attacker can plot an assault once they have the victim's vulnerability list. The attacker can use the list to get unauthorized access to the victim's system or network and compromising his information and security. If the victim seals all security holes in his system, an attacker will not be able to exploit his network or system. In order to ensure that his system is completely secure, the administrator must first determine whether there are any vulnerabilities within his own network or system. The administrator is responsible for conducting comprehensive vulnerability and penetration tests on the system or network (11). The administrator should fix the vulnerabilities found in his system as soon as he receives the inventory. To eliminate the vulnerabilities, the administrator must install the necessary software, apply the necessary fixes, and perform updates. When that was done, the administrator would make sure his system or network was completely secure. In the absence of any known security holes, an attacker would be unable to compromise the victim's computer system or network. In conclusion, doing vulnerability assessments and penetration tests can help a cyber-security system administrator save time, money, and sensitive data.

CONCLUSION

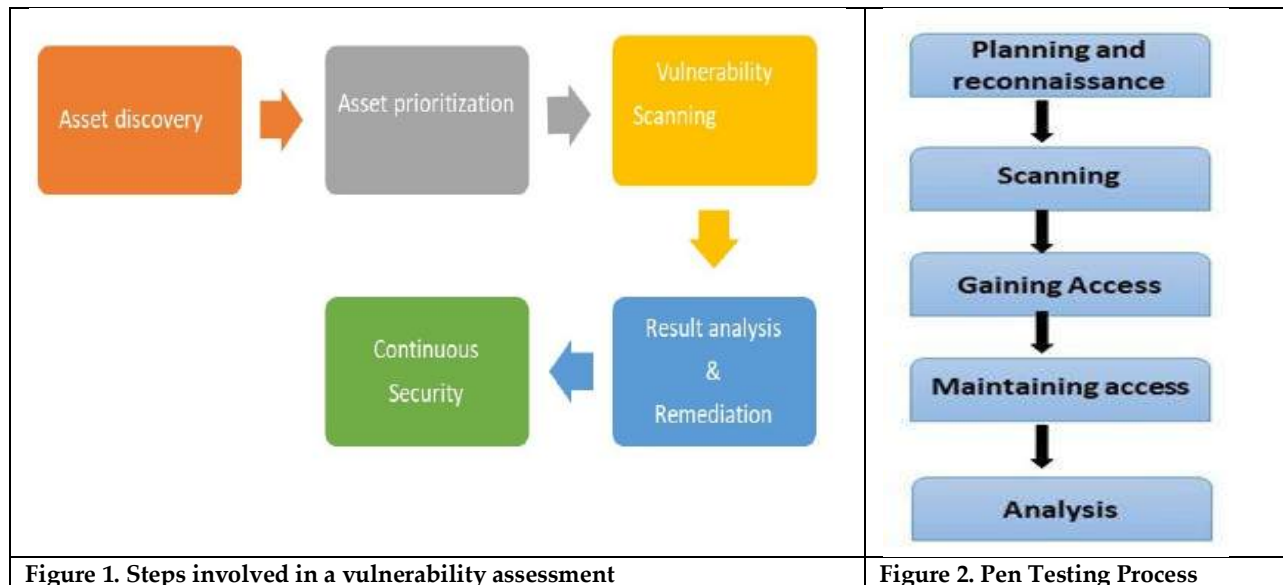
This review paper offers a thorough explanation of penetration testing and vulnerability assessment as cyber-security technologies. This paper explains why using VAPT more often is essential for total system security. Future researchers would find this work very useful in gaining a thorough understanding of the VAPT process, tools, and approaches, as well as how it is used as a cyber-security technology. It would be beneficial to create new VAPT methods and resources. VAPT is described in this research as a potent cyber protection tool. Mandatory VAPT testing can enhance system security and thwart cyberattack scenarios.





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Sikkim's Journey to Becoming India's First Organic State: A Historical Overview and the Policies That Facilitated This Transformation

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ABSTRACT

Sikkim's journey to becoming India's first fully organic state is a remarkable example of sustainable agricultural transformation. Initiated in 2003, the state government's vision was to eliminate chemical inputs and promote organic farming practices to safeguard both the environment and the health of its people. Over the next decade, the transition was facilitated by a series of comprehensive policies, including the Organic Mission Plan of 2010, which mandated the complete phase-out of synthetic pesticides and fertilizers. Sikkim adopted several strategies such as providing training to farmers, offering financial incentives, creating infrastructure for organic certification, and establishing markets for organic produce. These efforts culminated in Sikkim being declared fully organic in 2016. The state's policies also addressed environmental conservation, sustainable soil management, and biodiversity, aligning with global sustainability goals. This transformation has not only improved soil health and reduced environmental degradation but has also positioned Sikkim as a model for other regions aiming to embrace organic farming. The success of Sikkim's organic initiative highlights the crucial role of government support, farmer participation, and policy-driven frameworks in achieving large-scale agricultural sustainability. As Sikkim navigates future challenges in organic agriculture, its experience offers valuable insights into the holistic integration of ecological sustainability, economic development, and community empowerment.



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Keywords: Environmental Conservation, Organic Farming, Organic Certification, Policy Implementation, Sikkim, Sustainable Agriculture

INTRODUCTION

Sikkim, a small state nestled in the Eastern Himalayas, holds a unique place in India's agricultural history. Its journey to becoming the country's first fully organic state marks a significant milestone in the global push towards sustainable farming and environmental conservation (Prakash *et al.*, 2019; Avasthe *et al.*, 2020). With a population largely dependent on agriculture for livelihood, the state's decision to transform its entire farming system into an organic one is nothing short of revolutionary. This transformation, which officially began in 2003 and culminated in 2016, has turned Sikkim into a model for sustainable development, inspiring other states and countries to follow suit. The path to achieving full organic status, however, was neither short nor simple; it required a combination of visionary leadership, strong policy frameworks, grassroots involvement, and sustained efforts across multiple sectors (Bhutia *et al.*, 2016). Sikkim's agricultural journey was traditionally aligned with organic principles long before the advent of modern synthetic fertilizers and pesticides. Farmers in the region had been practicing age-old farming methods that were naturally organic, relying on locally available resources such as animal manure and plant-based nutrients. However, with the Green Revolution sweeping across India in the mid-20th century, even Sikkim began to adopt chemical inputs in agriculture to increase crop yields and meet rising food demands (Singh *et al.*, 2018). While the use of synthetic fertilizers and pesticides initially boosted agricultural productivity, it soon became apparent that these methods were unsustainable in the long run. The extensive use of chemicals led to soil degradation, loss of biodiversity, and contamination of water resources, posing a severe threat to the state's delicate ecosystem. Moreover, farmers increasingly found themselves dependent on expensive chemical inputs, which eroded their profit margins and trapped them in cycles of debt. With its rich biodiversity and fragile mountain ecosystem, Sikkim was particularly vulnerable to the environmental degradation caused by conventional farming (Babu *et al.*, 2020a). By the late 1990s, the need for a more sustainable approach to agriculture became evident. Farmers, policymakers, and environmentalists began to recognize that reverting to organic farming could not only restore soil health and protect biodiversity but also offer economic benefits by tapping into the growing global demand for organic produce.

Additionally, organic farming was viewed as a way to preserve Sikkim's cultural heritage, which had long been tied to environmentally friendly practices (Babu *et al.*, 2020b; Singh *et al.*, 2021b). The journey toward making Sikkim fully organic officially began in 2003 when the state's Chief Minister, Pawan Chamling, laid out a bold vision to transform the state's agricultural landscape. Chamling's leadership was instrumental in shaping this vision, as he recognized the long-term environmental, economic, and social benefits that organic farming could bring to the state (Bhutia *et al.*, 2016, Avasthe *et al.*, 2020). The organic mission was not merely about eliminating chemical inputs; it was a holistic approach aimed at improving the overall well-being of the state's population, enhancing food security, and positioning Sikkim as a leader in sustainable agriculture. The goal was ambitious: to convert the entire state to organic farming by phasing out the use of synthetic fertilizers and pesticides and replacing them with organic alternatives. This required a fundamental shift in both farming practices and attitudes, as well as a comprehensive strategy that involved multiple stakeholders, including farmers, government agencies, research institutions, and markets. The organic mission was seen as a way to not only protect the environment but also to promote the health and well-being of Sikkim's people, many of whom had been exposed to the harmful effects of chemical farming (Babu *et al.*, 2020c; Singh *et al.*, 2021a; Kumar *et al.*, 2022d). To translate this vision into reality, the Sikkim government launched the Sikkim Organic Mission in 2010, a flagship program that would serve as the cornerstone of the state's organic transformation. The Organic Mission Plan laid out a clear roadmap for achieving full organic status by 2015, with a focus on key areas such as farmer training, organic certification, and the development of markets for organic produce. The mission was divided into three phases: the preparatory phase (2003–2009), the implementation phase (2010–2015), and the post-organic phase (2016 onward). One of the first steps taken by the government was to completely ban the use of synthetic fertilizers and pesticides in the state (Singh *et al.*, 2021b; Kumar *et al.*, 2024). This was a bold and unprecedented move, as it effectively forced all farmers to transition to organic methods. To support





this transition, the government provided extensive training and capacity-building programs for farmers, teaching them about organic farming techniques such as composting, vermiculture, crop rotation, and natural pest control (Kumar *et al.*, 2022b). The government also established a network of organic certification bodies to ensure that farmers met the stringent standards required for organic farming. In addition to farmer training and certification, the government also focused on developing the necessary infrastructure to support organic farming. This included setting up organic input production units to supply farmers with organic fertilizers and pesticides, as well as creating cold storage facilities and processing units to help farmers store and market their produce. Recognizing the importance of market linkages, the government also worked to create markets for organic products, both within and outside the state. Sikkim's organic produce, including fruits, vegetables, and spices, found a growing market in metropolitan cities across India, as well as in international markets (Kumar *et al.*, 2022a). The Organic Mission Plan also emphasized the importance of research and innovation in organic farming. The government collaborated with various research institutions and universities to develop and promote organic farming technologies that were suitable for Sikkim's unique agro-climatic conditions (Kumar *et al.*, 2023). Extension services were also strengthened to provide farmers with technical support and advice on organic farming practices.

The transition to organic farming was not without its challenges. One of the biggest hurdles was convincing farmers to adopt organic methods, particularly in the initial stages when yields tended to be lower compared to conventional farming. Many farmers were skeptical about the benefits of organic farming and were hesitant to give up the use of synthetic fertilizers and pesticides, which they had come to rely on for increasing productivity. To address these concerns, the government provided financial incentives to farmers who adopted organic farming. This included subsidies for organic inputs, as well as price premiums for organic produce. Farmers who successfully transitioned to organic farming were also given priority access to government schemes and programs (Babu *et al.*, 2020d; Kumar *et al.*, 2022b). Additionally, the government set up demonstration farms to showcase the benefits of organic farming and encourage more farmers to make the switch. Another challenge was the need to develop a robust supply chain for organic produce. Since organic farming requires careful handling to prevent contamination, the government had to invest in creating separate supply chains for organic products, from farm to market. This included setting up organic certification processes, developing storage and transportation facilities, and ensuring that organic products were clearly labeled and differentiated from conventional ones (Babu *et al.*, 2020b; Kumar *et al.*, 2022c). Despite these challenges, the state's organic mission continued to gain momentum, thanks to the strong political will of the government and the active participation of farmers and other stakeholders. By 2016, Sikkim had successfully achieved its goal of becoming a fully organic state, with over 75,000 hectares of agricultural land certified as organic. Sikkim's transition to organic farming has had a profound impact on the state's environment, economy, and society. From an environmental perspective, the elimination of chemical inputs has led to significant improvements in soil health, water quality, and biodiversity (Sharma, 2020; Babu *et al.*, 2020a; Singh *et al.*, 2023). The use of organic fertilizers and pest control methods has helped to restore soil fertility, reduce erosion, and increase the resilience of crops to climate change. The state's rich biodiversity has also been preserved, with organic farming helping to protect the habitat of numerous plant and animal species. Economically, the shift to organic farming has opened up new opportunities for farmers (Bhandari & Bhattacharya, 2018). Organic produce commands a premium price in both domestic and international markets, and Sikkim's organic products have gained a reputation for their high quality and authenticity (Babu *et al.*, 2023).

The state's organic farming initiative has also attracted tourists, with many visitors coming to Sikkim to experience its organic farms and sample its organic cuisine. Socially, the organic movement has had a positive impact on the health and well-being of Sikkim's population. By eliminating the use of harmful chemicals in agriculture, the state has reduced the exposure of farmers and consumers to toxic substances, leading to better health outcomes. Organic farming has also helped to strengthen the state's rural economy, providing farmers with more stable and sustainable incomes.



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Historical context

Traditional Agricultural Practices

Sikkim's agricultural heritage is rich and diverse, deeply intertwined with the region's ecological and cultural fabric. For centuries, local farmers have practiced a form of agriculture that emphasizes sustainability and harmony with nature. Traditional farming methods in Sikkim include the cultivation of staple crops such as rice, maize, millet, and various vegetables, often utilizing techniques that enhance soil fertility and promote biodiversity. Farmers employed practices such as crop rotation, which helps maintain soil health and reduce pest populations, and intercropping, where multiple crops are grown together to optimize space and resources (Kumar *et al.*, 2017; Avasthe *et al.*, 2020). The use of organic matter, such as compost and farmyard manure, was common, enriching the soil without depleting it of nutrients. Additionally, local knowledge systems and indigenous varieties of crops contributed to the resilience of the agricultural landscape, allowing farmers to adapt to the region's challenging climatic conditions (Ghosh, 2015; Bhutia *et al.*, 2016). However, the latter half of the 20th century saw a shift towards modern agricultural practices, driven by the Green Revolution and the increasing availability of chemical fertilizers and pesticides. This shift was marked by a quest for higher yields, often at the expense of traditional methods. While initially, these inputs led to increased production, they also brought significant environmental and health concerns. The indiscriminate use of chemical fertilizers resulted in soil degradation, reduced biodiversity, and water contamination, while pesticide use raised alarming health issues for farmers and consumers alike (Bhattacharyya, 2014; Kumar *et al.*, 2024). Farmers began to notice negative impacts, such as declining soil fertility and increased pest resistance, which diminished the effectiveness of chemical inputs over time. Additionally, the reliance on chemicals contributed to health problems, including respiratory issues and skin diseases among agricultural workers (Bhan&Raghavan, 2016; Babu *et al.*, 2020a). This growing awareness of the detrimental effects of chemical farming led to a gradual re-evaluation of agricultural practices in Sikkim, paving the way for the revival of traditional and sustainable farming methods. The return to organic practices was not merely a rejection of chemicals but a rediscovery of sustainable agricultural traditions that prioritized ecological balance and community health. This transition set the stage for Sikkim's eventual designation as India's first fully organic state, showcasing the resilience and adaptability of local farming communities in the face of modern agricultural challenges (Prakash *et al.*, 2019; Kumar *et al.*, 2023). Sikkim's agrarian history is rooted in diverse indigenous practices that prioritize sustainability. Farmers traditionally cultivated crops like rice, maize, and various vegetables using methods that maintained soil fertility and biodiversity. Despite these practices, the introduction of chemical fertilizers and pesticides in the late 20th century led to environmental concerns and health issues. In the 1990s, rising awareness of the adverse effects of chemical farming prompted a grassroots movement advocating for organic practices. Local farmers, NGOs, and environmental activists began to promote sustainable alternatives.

The Organic Transition

The organic transition refers to the process by which conventional agricultural systems are converted into organic farming systems, prioritizing sustainability, environmental conservation, and human health. This shift involves eliminating the use of synthetic inputs like chemical fertilizers and pesticides, and adopting natural farming practices such as crop rotation, composting, and biological pest control (Fig 1).

Policy Initiatives

In 2003, the Sikkim government took a landmark step by formally declaring its intent to transition to organic farming, making it the first state in India to embark on such an ambitious journey. This initiative aimed to drastically reduce the use of chemical fertilizers and pesticides, promoting instead environmentally friendly agricultural practices that would benefit both the ecosystem and the health of the local population (Fig 1) (Bhattacharyya, 2014; Singh *et al.*, 2021a). The government launched the Sikkim Organic Mission, a comprehensive framework designed to facilitate this transition. This mission not only promoted organic farming methods but also established protocols for the certification of organic produce, ensuring that products from Sikkim could compete in broader markets (Sharma, 2020). The Organic Mission provided critical support in the form of training programs for farmers, focusing on the adoption of organic practices, pest management, and sustainable land use. These efforts aimed to empower local





farmers with the knowledge and tools necessary to transition from conventional methods to organic practices, fostering a culture of sustainability within the agricultural community (Ghosh, 2015; Singh *et al.*, 2021b).

Supportive Legislation

To complement the Organic Mission, the Sikkim government implemented various laws and guidelines designed to facilitate organic farming. This supportive legislative framework included financial incentives for farmers transitioning to organic practices, as well as technical assistance for the establishment of organic farming operations (Bhan & Raghavan, 2016; Bhutia *et al.*, 2016). The state also developed guidelines for organic certification, which were essential for ensuring that products met national and international organic standards. These policies not only provided immediate support to farmers but also laid the groundwork for a robust organic agriculture sector. By facilitating market access through government-sponsored initiatives, Sikkim positioned itself as a leader in the organic farming movement in India (Prakash *et al.*, 2019).

Training and Education

Recognizing the importance of education in successful agricultural transitions, the Sikkim government collaborated with various NGOs and agricultural universities to initiate extensive training programs for farmers. These programs were crucial in educating farmers about organic farming techniques, pest management without chemicals, soil health maintenance, and sustainable agricultural practices (Kumar *et al.*, 2017; Kumar *et al.*, 2024). Workshops, field demonstrations, and training sessions were organized to provide hands-on learning experiences, enabling farmers to share knowledge and best practices. The involvement of local communities in these educational initiatives ensured that the training was relevant and tailored to the specific needs of Sikkim's diverse agricultural landscape (Sharma, 2020; Babu *et al.*, 2020a). This multi-faceted approach—encompassing policy initiatives, supportive legislation, and comprehensive training—created a conducive environment for the successful transition to organic farming in Sikkim. The collaborative efforts between the government, NGOs, and local farmers fostered a resilient agricultural community committed to sustainable practices and the long-term health of their environment.

Community Involvement

Cooperatives and Farmer Groups

The establishment and rise of cooperatives have been instrumental in the success of organic farming in Sikkim. By organizing themselves into cooperatives, farmers have been able to pool their resources, share knowledge, and enhance their bargaining power in the marketplace. These groups facilitate the bulk selling of organic produce, which not only increases efficiency but also helps ensure that farmers receive fair prices for their products (Bhan & Raghavan, 2016; Babu *et al.*, 2020c). Cooperatives such as the Sikkim Organic Farmers' Cooperative Society have emerged as key players in the organic supply chain, enabling farmers to access larger markets and gain visibility for their products. These organizations provide support in various forms, including logistics, marketing, and technical assistance, which are crucial for smallholder farmers who may lack the resources to navigate the complexities of organic certification and marketing independently (Ghosh, 2015; Prakash *et al.*, 2019; Kumar *et al.*, 2022a). The collaborative nature of cooperatives also fosters a sense of community among farmers, promoting the sharing of best practices and innovations in organic farming techniques (Sharma, 2020).

Awareness Campaigns

Alongside cooperative initiatives, awareness campaigns conducted by the state government and non-governmental organizations (NGOs) have played a vital role in promoting organic farming in Sikkim. These campaigns aim to educate the public about the environmental and health benefits of organic produce, thereby creating a consumer base that is eager to support local organic farmers (Kumar *et al.*, 2017). For example, initiatives such as the "Go Organic" campaign not only highlighted the benefits of organic farming but also engaged consumers through workshops, farm visits, and educational materials that explain the importance of sustainability (Bhandari & Bhattacharya, 2018). By raising awareness about the positive impacts of organic farming, these campaigns have helped shift consumer preferences towards organic products, contributing to an increase in demand and market opportunities for Sikkim's farmers (Singh & Yadav, 2020; Singh *et al.*, 2021a). The collaborative efforts between cooperatives and awareness



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campaigns have collectively strengthened the organic movement in Sikkim, ensuring that both farmers and consumers are actively engaged in the transition to sustainable agriculture.

Economic Impact**Market Development**

Sikkim has made significant strides in developing infrastructure to support the marketing of organic products, which has proven beneficial for local farmers. The establishment of farmer markets across the state has enabled producers to sell their goods directly to consumers, cutting out middlemen and ensuring better prices for their organic produce (Kumar *et al.*, 2017). These markets serve as vital platforms for farmers to showcase their products, fostering a direct connection with consumers and enhancing awareness of organic farming. In addition to physical markets, the state has also embraced digital platforms to expand market reach. Online selling initiatives allow farmers to access broader markets beyond Sikkim, enabling them to sell organic products like cardamom, ginger, and organic teas directly to consumers and retailers across India and internationally (Prakash *et al.*, 2019; Kumar *et al.*, 2022c). The rise in demand for organic products has positioned Sikkim as a recognizable brand in the organic farming sector, further enhancing the economic viability of local agriculture (Bhattacharyya, 2014; Babu *et al.*, 2020d). The state government has actively promoted export opportunities for its organic products, facilitating connections with international buyers and participating in trade fairs to showcase Sikkim's offerings (Sharma, 2020; Avasthe *et al.*, 2020). This expansion into global markets not only increases farmers' incomes but also contributes to the overall economic development of the state.

Tourism and Eco-Friendly Initiatives

Organic farming has become a cornerstone of Sikkim's tourism strategy, attracting visitors interested in sustainable agriculture and eco-friendly practices. The state has leveraged its commitment to organic farming to promote agri-tourism, where visitors can experience organic farming firsthand, participate in workshops, and explore the natural beauty of Sikkim (Bhandari & Bhattacharya, 2018). This approach not only supports local economies but also raises awareness about sustainable practices among tourists. Tourism initiatives related to organic farming have been designed to showcase the agricultural landscape of Sikkim, promoting experiences that align with eco-friendly values. Farm stays and guided tours through organic farms have become popular, allowing visitors to engage with local farmers and learn about organic farming techniques (Ghosh, 2015; Bhutia *et al.*, 2016). The emphasis on sustainability and organic produce in tourism marketing has helped Sikkim attract a niche market of eco-conscious travelers, contributing significantly to the state's economy. By integrating organic farming into its tourism sector, Sikkim has not only diversified its economic base but also reinforced its identity as a leader in sustainable development. This dual approach—enhancing market access for organic products and promoting eco-friendly tourism—has created a synergistic effect, benefiting both the agricultural sector and the broader economy of Sikkim (Singh & Yadav, 2020; Babu *et al.*, 2023).

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Future Prospects

Sustainability and Resilience

Sikkim's organic farming model serves as a beacon for other regions in India and beyond, particularly as the impacts of climate change increasingly threaten agricultural viability. The organic methods adopted in Sikkim—such as crop rotation, intercropping, and the use of organic fertilizers—enhance soil health and biodiversity, making the agricultural system more resilient to climate-related stresses (Bhutia *et al.*, 2016; Prakash *et al.*, 2019). As weather patterns become more erratic and extreme events more common, organic farming practices that emphasize ecological balance will be critical in ensuring food security and sustainability. Research has shown that organic farming can help mitigate some effects of climate change by sequestering carbon in the soil and reducing dependency on fossil fuels through less intensive agricultural practices (Kumar *et al.*, 2017). Sikkim's experience demonstrates how integrating sustainable agricultural practices can lead to long-term environmental benefits, making it a valuable model for regions facing similar challenges (Bhan & Raghavan, 2016; Kumar *et al.*, 2022d). As other states consider transitioning to organic farming, they can learn from Sikkim's success and adapt its practices to local contexts, ultimately contributing to a more resilient agricultural sector nationwide (Ghosh, 2015).

Continuous Support

To ensure the sustainability of its organic farming initiatives, ongoing government support and investment in research, education, and infrastructure are essential. Continued financial assistance for farmers transitioning to organic practices, as well as investments in infrastructure for storage and transportation of organic produce, will be critical to maintaining the momentum of Sikkim's organic movement (Sharma, 2020; Singh *et al.*, 2021b). Additionally, research into sustainable agricultural practices tailored to Sikkim's unique climatic and ecological conditions will help farmers adapt to emerging challenges. Collaborations with agricultural universities and research institutions can provide the necessary data and innovations to improve productivity and sustainability in organic farming (Singh & Yadav, 2020). The government's role in facilitating educational programs for farmers, focusing on best practices in organic agriculture, pest management, and market access, will also be crucial. By fostering a well-informed farming community, Sikkim can ensure that its agricultural practices remain robust and adaptive in the face of changing conditions (Kumar *et al.*, 2017; Singh *et al.*, 2018). Sikkim's journey to becoming India's first organic state is a testament to the power of community, policy innovation, and sustainable practices. The successful transition not only benefits the local environment and economy but also serves as an inspiring model for other regions seeking to embrace organic farming. With continued support and commitment, Sikkim can further strengthen its position as a





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leader in sustainable agriculture, demonstrating the viability and benefits of organic farming on a larger scale (Avasthe et al., 2020).

CONCLUSION

Sikkim, India's first fully organic state, has demonstrated the power of community engagement, innovative policy-making, and sustainable agricultural practices. The transition, initiated through the Sikkim Organic Mission, has improved soil health, biodiversity, and economic prospects for its farming communities. The initiative has also positioned Sikkim as a leading eco-tourism destination, attracting visitors interested in sustainable practices and environmental conservation. This dual focus on agriculture and tourism has generated additional income streams for local communities and raised awareness about the benefits of organic farming globally. Sikkim's experience serves as a model for other regions in India and worldwide, with its commitment to continuous education, research, and community empowerment inspiring similar initiatives. Sikkim's pioneering efforts demonstrate that organic farming is not just an alternative agricultural method but a viable pathway to holistic development. By fostering ecological sustainability, economic resilience, and social cohesion, Sikkim exemplifies how organic agriculture can contribute to a healthier planet and more equitable society. As the world grapples with pressing environmental issues and climate change effects, Sikkim stands as a beacon of hope, showcasing the potential of organic farming as a transformative force for sustainable development.

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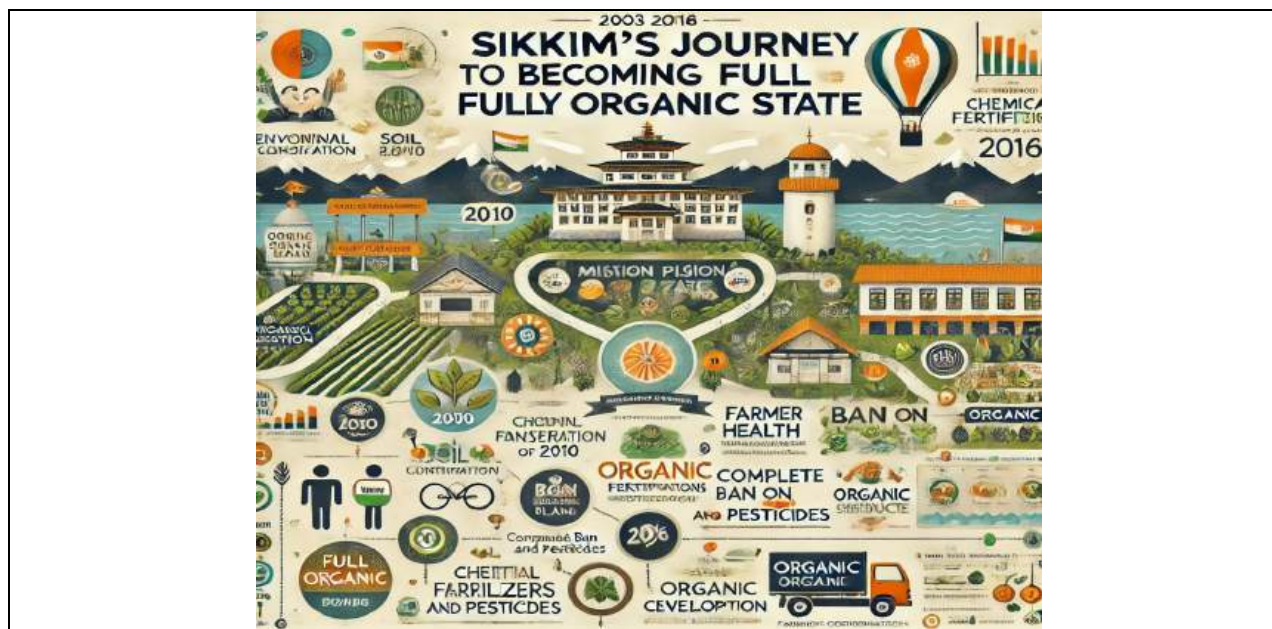
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Impact of Robotics and AI in the Future of Manufacturing Supply Chain: A Comprehensive Review

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ABSTRACT

The increasing integration of robotics and artificial intelligence (AI) into manufacturing supply chains is revolutionizing traditional systems by enhancing efficiency, reducing costs, and improving overall performance. This comprehensive review explores the impacts of these technologies on supply chain operations, from procurement and production to distribution and logistics. The study delves into key trends, challenges, and future opportunities, providing insights into how robotics and AI are reshaping the manufacturing landscape. Key technological advancements, such as automation, machine learning, and predictive analytics, are also examined. The paper concludes with a discussion on the future trajectory of manufacturing supply chains and the role that these emerging technologies will play in driving innovation.

Keywords: Robotics, Artificial Intelligence (AI), Manufacturing Supply Chain, Industry 4.0, Automation

INTRODUCTION

In recent years, the rapid development of robotics and AI has had a profound impact on industries worldwide. The manufacturing supply chain, being one of the most dynamic sectors, has particularly benefited from these technologies. Traditional manufacturing methods are being replaced by highly automated, intelligent systems that can perform tasks with precision and efficiency. The digital transformation of supply chains involves the use of AI for predictive analytics, demand forecasting, and process optimization, while robotics enhances physical operations such as assembly, packaging, and transportation. This paper presents a comprehensive review of how robotics and AI are shaping the future of manufacturing supply chains and what trends and challenges lie ahead.



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The manufacturing landscape is undergoing a seismic shift as industries increasingly integrate advanced technologies, particularly robotics and artificial intelligence (AI), into their supply chains. This evolution is not merely a trend but a necessary adaptation to meet the demands of a rapidly changing global marketplace characterized by heightened competition, evolving consumer expectations, and the pressing need for operational efficiency. The advent of Industry 4.0—often referred to as the fourth industrial revolution—has set the stage for this transformation, emphasizing the convergence of physical and digital technologies within manufacturing processes.

Robotics and AI are at the forefront of this revolution, driving significant improvements in productivity, accuracy, and flexibility. Robotics have long been utilized in manufacturing, primarily for repetitive and labor-intensive tasks. However, recent advancements have enabled the development of more sophisticated robots that can perform complex functions and work collaboratively with human operators. These robots are now equipped with sensors, vision systems, and AI algorithms that allow them to adapt to dynamic environments, making them indispensable in modern manufacturing settings. AI plays a complementary role by providing intelligent decision-making capabilities that enhance the effectiveness of robotic systems. Machine learning algorithms can analyze vast amounts of data generated across the supply chain, enabling predictive analytics that inform production planning, inventory management, and demand forecasting. This capability not only improves operational efficiency but also reduces costs and enhances overall supply chain responsiveness.

Despite the clear benefits, the integration of robotics and AI in manufacturing supply chains is not without challenges. Companies face significant hurdles, including high initial costs, the need for skilled personnel, and potential workforce displacement. The fear of job losses due to automation has sparked debates about the future of work and the necessary reskilling of employees to prepare them for new roles that these technologies create. Furthermore, as manufacturing systems become more interconnected, the risks associated with cyber security and data breaches have escalated, demanding robust strategies to safeguard operations. This comprehensive review aims to explore the multifaceted impacts of robotics and AI on the future of manufacturing supply chains. It will delve into the technological advancements that have enabled this transformation, the benefits and challenges associated with their implementation, and the emerging trends that will shape the industry in the coming years. By understanding these dynamics, manufacturers can better position themselves to leverage these technologies for competitive advantage, ultimately driving innovation and growth in an increasingly complex and interconnected global economy. The integration of robotics and AI holds the promise of a more efficient, flexible, and resilient manufacturing landscape, paving the way for future advancements in the supply chain.

Technological Integration in Supply Chains**Robotics in Manufacturing Supply Chains**

The integration of robotics into supply chains has enhanced operational capabilities, especially in repetitive and labour-intensive tasks. Robotics in warehouses has optimized picking, packing, and inventory management processes, drastically reducing human error and operational costs [1]. Collaborative robots (cobots) are increasingly being used to work alongside human operators, assisting in assembly lines and ensuring consistent quality and productivity [2]. The integration of robotics into manufacturing supply chains has revolutionized operations by automating labour-intensive and repetitive tasks, significantly improving efficiency. Robots are utilized in various stages of supply chains, from assembly lines to warehousing, where they perform tasks like picking, packing, and sorting with high precision. A notable example is the use of collaborative robots (cobots) that work alongside human operators, helping in complex assembly tasks and boosting productivity. These robots are equipped with advanced sensors and algorithms that enable safe human-robot interaction, leading to enhanced output while reducing workplace injuries.

Autonomous mobile robots (AMRs) have also gained traction in warehouses, where they streamline intra-facility transportation. These robots are equipped with cutting-edge AI-based navigation systems that allow them to navigate dynamic environments, avoid obstacles, and optimize their travel paths, leading to time and cost savings. AMRs can dynamically adjust to changes in warehouse layouts and operations, improving overall efficiency in



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material handling. Robotics is now crucial in meeting the demands of a globalized economy, where speed, accuracy, and scalability are paramount. With continuous advancements in robotic technologies and decreasing hardware costs, their adoption is expected to expand further, transforming traditional supply chain operations into highly automated, efficient systems [1]–[4]. The rise of autonomous mobile robots (AMRs) has also transformed intra-warehouse transportation, allowing for the efficient movement of materials and products across facilities [3]. These robots are equipped with advanced navigation systems, powered by AI algorithms, to optimize their routes and avoid collisions, thus improving safety and operational efficiency [4].

AI in Supply Chain Management

AI applications in supply chain management (SCM) are varied, encompassing tasks such as demand forecasting, inventory optimization, and risk management. Machine learning (ML) algorithms have enabled more accurate predictions of demand fluctuations, allowing manufacturers to adjust production schedules and stock levels dynamically [5]. Furthermore, AI-driven predictive maintenance systems can detect early signs of equipment failure, reducing downtime and enhancing operational reliability [6]. Artificial intelligence (AI) has become a powerful tool in supply chain management (SCM), enabling companies to optimize processes, predict market trends, and reduce operational risks. One of the key applications of AI in SCM is demand forecasting, where machine learning (ML) models analyze historical data, market conditions, and external factors to provide accurate predictions of product demand. These forecasts help manufacturers adjust their production plans, minimize inventory costs, and prevent overproduction or stock outs. AI also facilitates inventory optimization by predicting reorder points and ensuring the right quantities of products are stored at different stages of the supply chain. AI-driven predictive maintenance is another critical application that uses machine learning to monitor equipment health in real time. By analyzing sensor data from machines, AI can predict failures before they occur, enabling companies to perform maintenance proactively and avoid costly downtimes. Furthermore, natural language processing (NLP) and computer vision are being used to analyze unstructured data sources, such as social media and customer reviews, providing valuable insights into consumer preferences and helping companies adjust their strategies accordingly. As AI technologies evolve, they will continue to enhance decision-making and improve the overall efficiency and resilience of supply chains [5]–[8]. Natural language processing (NLP) and computer vision are also being employed to analyze unstructured data, such as customer reviews and social media trends, to better understand market needs and optimize product development [7]. AI-based decision-support systems are now aiding managers in making data-driven decisions that maximize supply chain efficiency [8].

Benefits of Robotics and AI in Manufacturing Supply Chains**Enhanced Productivity**

One of the primary benefits of integrating robotics and AI is the substantial increase in productivity. Robots can work continuously without fatigue, while AI algorithms can rapidly analyse vast amounts of data to identify inefficiencies and optimize processes [9]. The combination of these technologies allows manufacturers to achieve greater output with fewer resources, translating into cost savings and improved profitability [10]. The integration of robotics and AI technologies into manufacturing supply chains has resulted in a dramatic increase in productivity. Robotics, particularly in the form of automated systems, allows for 24/7 operations without the limitations of human fatigue. Robots perform tasks with unmatched speed and precision, drastically reducing the time required for repetitive processes, such as assembly, packaging, and quality inspections. AI, on the other hand, analyzes vast amounts of data in real-time, identifying bottlenecks, predicting outcomes, and optimizing workflows, which further enhances the efficiency of supply chain operations. AI-powered systems optimize production schedules by dynamically adjusting them based on real-time demand, inventory levels, and production capacity, ensuring that resources are allocated in the most efficient way possible. In logistics, AI-driven systems improve routing and transportation efficiency, reducing fuel consumption and delivery times. The combination of robotics and AI enables manufacturers to achieve greater throughput with fewer resources, leading to significant cost savings and higher profit margins. As these technologies continue to advance, they are expected to further augment productivity, especially in industries that require high precision and scalability in their operations [9]–[10].



**Ranjan Behera****Improved Accuracy and Quality**

Automation provided by robotics ensures consistent quality across manufacturing processes. AI systems can monitor production lines in real-time, identifying defects and making adjustments as needed, thus minimizing waste and rework [11]. The implementation of vision systems for quality control further improves product consistency, reducing the likelihood of errors that would otherwise be detected post-production [12]. Automation driven by robotics and AI is a game-changer in terms of accuracy and quality in manufacturing processes. Robots are capable of performing tasks with consistent precision, ensuring that each product is manufactured to exact specifications. This consistency minimizes the likelihood of defects, which reduces waste, rework, and the overall cost of production. In environments where even minor variations can lead to significant issues, such as in the electronics or automotive industries, the role of robotics in maintaining product quality is indispensable. AI systems further enhance accuracy by integrating real-time monitoring and feedback mechanisms into the manufacturing process. Advanced machine learning algorithms can detect deviations in production, such as equipment malfunctions or material inconsistencies, and immediately adjust parameters to correct them. Vision systems powered by AI are commonly used for quality inspections, identifying defects that may not be visible to the human eye. These systems ensure that only products meeting the required standards make it to the end of the production line, thus improving overall quality control. Through such innovations, robotics and AI help manufacturers achieve superior product quality, which enhances brand reputation and customer satisfaction [11]–[12].

Flexibility and Scalability

Robotics and AI enable greater flexibility in manufacturing operations. AI systems can quickly adapt to changing market conditions by adjusting production schedules, while robots can be reprogrammed to handle new tasks without significant downtime [13]. This adaptability is crucial for manufacturers that need to respond to fluctuating demand or introduce new products [14]. Robotics and AI provide manufacturers with the flexibility and scalability needed to compete in today's fast-paced, demand-driven market. Traditional manufacturing systems are often rigid, requiring significant time and resources to adapt to changes in product designs or production volumes. In contrast, robots can be easily reprogrammed to perform new tasks, allowing manufacturers to quickly adapt to changes in customer demand or introduce new products without significant downtime. This agility is crucial in industries with short product life cycles or where product customization is key. AI systems contribute to flexibility by dynamically optimizing production schedules and resource allocation based on real-time data. For instance, AI algorithms can analyze market trends, customer preferences, and inventory levels to adjust production plans, ensuring that manufacturers can meet fluctuating demand without overproducing. Scalability is another critical advantage, as robotic systems can be easily expanded or reduced in capacity by adding or removing machines, depending on production needs. This makes it easier for manufacturers to scale their operations without investing in entirely new infrastructure, giving them a competitive edge in rapidly evolving markets [13]–[14].

Challenges in Implementing Robotics and AI**High Initial Costs**

The adoption of robotics and AI technologies often requires substantial capital investment. The cost of purchasing and integrating advanced robots, along with the development of AI systems, can be prohibitive for small and medium-sized enterprises (SMEs) [15]. Additionally, the need for skilled personnel to operate and maintain these systems adds to the financial burden [16]. One of the main challenges associated with the adoption of robotics and AI in manufacturing supply chains is the high initial cost. The capital investment required for acquiring, installing, and integrating advanced robotics systems can be prohibitive, particularly for small and medium-sized enterprises (SMEs). These costs include not only the physical robots and AI infrastructure but also the software, customization, and installation required to ensure that these systems function seamlessly within existing operations. Additionally, ongoing costs such as maintenance, software updates, and the need for highly skilled personnel to operate and manage these systems add to the financial burden. For many businesses, the return on investment (ROI) for robotics and AI may not be immediately apparent, especially in the early stages of adoption. The significant upfront costs can delay ROI, particularly in industries with narrow profit margins or low production volumes. Despite the long-term benefits of these technologies, including improved efficiency, reduced labor costs, and enhanced production



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capabilities, the initial financial hurdle remains a key barrier to widespread adoption. Over time, however, as the cost of robotics and AI technologies decreases, and as businesses realize the potential for substantial long-term gains, the adoption rates are expected to increase [15]–[16].

Cyber security Risks

As manufacturing supply chains become increasingly connected through AI and robotics, the risk of cyberattacks grows. Hackers can target automated systems to disrupt operations, steal sensitive data, or sabotage production lines [17]. Ensuring the cybersecurity of these technologies is a critical challenge that must be addressed to safeguard supply chains [18]. The integration of AI and robotics into supply chains introduces significant cybersecurity risks. As supply chains become more digitized and interconnected, they become increasingly vulnerable to cyberattacks. Hackers can target automated systems, including robots and AI algorithms, to disrupt operations, steal intellectual property, or manipulate production processes. This is particularly concerning in industries like pharmaceuticals, automotive, or defence, where the integrity of production processes is critical. AI systems, which rely heavily on vast amounts of data, are also susceptible to data breaches. Unauthorized access to sensitive data, such as trade secrets, supplier information, or customer data, can lead to significant financial and reputational damage. Additionally, AI algorithms themselves can be compromised if malicious actors introduce corrupted data, leading to incorrect predictions or decisions. To mitigate these risks, manufacturers must invest in robust cybersecurity measures, including encryption, secure communication protocols, and AI-based anomaly detection systems that can identify potential security threats in real time. Cybersecurity must be a top priority for companies adopting robotics and AI to ensure the safety and resilience of their supply chains [17]–[18].

Workforce Displacement

The automation of manufacturing processes through robotics and AI poses a threat to jobs traditionally performed by humans. While these technologies can lead to increased efficiency, they also raise concerns about workforce displacement, particularly in labour-intensive roles [19]. However, new opportunities may arise for workers to be retrained and redeployed in higher-skilled positions, such as robot programming and system maintenance [20]. The automation of manufacturing processes through robotics and AI has raised concerns about workforce displacement. As robots and AI systems take over tasks traditionally performed by human workers, particularly in labour-intensive roles, there is a growing fear that large portions of the workforce may become obsolete. This is particularly true in sectors where repetitive, manual tasks are prevalent, such as assembly lines, warehousing, and logistics. While the introduction of robotics can lead to greater efficiency and cost savings for businesses, it also creates the risk of job losses for low-skilled workers. However, while automation may reduce the demand for certain types of labour, it also creates opportunities for new types of jobs. As robots and AI systems require maintenance, programming, and supervision, there is an increased demand for workers with specialized skills in robotics, AI, and data analysis. To mitigate the negative impact on employment, companies and governments need to invest in upskilling and reskilling initiatives that prepare workers for the new roles created by these technologies. Workforce displacement can thus be managed by proactively addressing the skills gap and preparing workers for the future of work in a more automated world [19]–[20].

Future Trends and Opportunities**AI-Driven Supply Chain Optimization**

The future of manufacturing supply chains lies in the further optimization of processes using AI. Advancements in AI algorithms, such as reinforcement learning and deep learning, will enable more autonomous decision-making across the supply chain [21]. This will result in more efficient logistics, better resource allocation, and reduced lead times [22]. AI-driven supply chain optimization is poised to revolutionize how manufacturers manage their operations. AI technologies, particularly machine learning and advanced analytics, will play an increasingly important role in making supply chains more efficient, resilient, and responsive to market changes. Reinforcement learning, a subset of AI, is expected to become more prevalent in supply chain management. This technology allows AI systems to learn optimal strategies by interacting with the environment and receiving feedback, enabling them to make data-driven decisions that improve efficiency and reduce costs. Furthermore, AI can help businesses achieve



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greater transparency across their supply chains. By leveraging predictive analytics, companies can anticipate disruptions, identify potential risks, and develop contingency plans to mitigate these challenges. This proactive approach will enhance supply chain resilience and ensure continuity of operations in the face of uncertainties. As more companies adopt AI technologies, there will also be a shift towards more collaborative supply chains, where data sharing and joint decision-making are prioritized to enhance overall performance. The future of manufacturing supply chains will increasingly rely on AI to optimize processes, enhance decision-making, and drive competitive advantage [21]–[22].

Expansion of Robotics in Supply Chains

The use of robots in manufacturing will continue to expand, driven by advancements in robotics technology and falling hardware costs. New generations of robots, equipped with more sophisticated AI, will handle increasingly complex tasks, from product customization to autonomous logistics operations [23]. The integration of AI with robotic systems will lead to fully autonomous factories, where human intervention is minimal [24]. The future of robotics in manufacturing supply chains looks promising, with significant advancements expected in capabilities and applications. As robotic technology continues to evolve, the use of more sophisticated robots capable of performing complex tasks will increase. These next-generation robots will not only be more autonomous but also more adaptable to varying production requirements, making them suitable for a broader range of industries. The trend toward automation is also expected to expand into areas previously dominated by manual labor, such as quality control, packaging, and even customer service. Enhanced sensors, machine learning, and AI integration will enable robots to take on increasingly complex tasks while interacting more effectively with human workers. The proliferation of cobots—robots designed to work alongside humans—will foster collaborative environments that maximize the strengths of both human and robotic capabilities. Moreover, as industries increasingly embrace Industry 4.0 principles, the integration of robotics with the Internet of Things (IoT) will further enhance operational efficiency. Robots equipped with IoT capabilities can communicate with other machines and systems, allowing for real-time monitoring and optimization of supply chain processes. The future will see a more extensive deployment of robotics, resulting in more efficient, flexible, and responsive manufacturing supply chains [23]–[24].

AI and Block Chain Integration

Another emerging trend is the integration of AI with blockchain technology to enhance supply chain transparency and traceability. AI algorithms can process the vast amount of data stored on blockchain networks to provide real-time insights into supply chain operations, helping manufacturers to track goods, reduce fraud, and ensure compliance with regulations [25]. The integration of AI and blockchain technology represents a transformative opportunity for manufacturing supply chains. Blockchain provides a decentralized and immutable ledger that enhances transparency and traceability, while AI can analyze the vast amounts of data generated within blockchain networks to derive actionable insights. Together, these technologies can address some of the critical challenges faced by supply chains, including fraud, counterfeiting, and inefficiencies. By leveraging AI algorithms, companies can analyze blockchain data to monitor supply chain activities in real-time, ensuring that products are sourced ethically and comply with regulatory standards. For example, AI can help identify anomalies or discrepancies in transactions recorded on the blockchain, flagging potential issues before they escalate. This proactive approach not only enhances security but also builds trust among stakeholders, including suppliers, manufacturers, and consumers. Additionally, AI can optimize logistics and inventory management by analyzing data from blockchain systems, helping manufacturers make informed decisions about sourcing, production, and distribution. The combination of AI and blockchain will enable more efficient and secure supply chains, ultimately leading to enhanced operational performance and customer satisfaction. As these technologies continue to evolve, their integration will shape the future of supply chain management, making it more resilient and transparent [25].





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CONCLUSION

The future of manufacturing supply chains is undoubtedly intertwined with advancements in robotics and AI. These technologies are transforming the way supply chains operate, improving efficiency, accuracy, and flexibility while reducing costs. However, challenges such as high initial costs, cybersecurity risks, and workforce displacement must be addressed to ensure the sustainable adoption of these technologies. As robotics and AI continue to evolve, they will unlock new opportunities for innovation, driving the next wave of transformation in global manufacturing supply chains.

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Enhancing IoT Security through Blockchain-Based Solutions: A Comprehensive Review and Analysis

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ABSTRACT

The Internet of Things (IoT) has revolutionized various industries, enabling seamless connectivity and communication among devices. However, the proliferation of IoT devices has also brought forth unprecedented security challenges, making them vulnerable to various cyber threats. In recent years, blockchain technology has emerged as a potential solution to bolster IoT security, leveraging its decentralized, immutable, and transparent nature to secure IoT ecosystems. This research paper explores the application of blockchain in enhancing IoT security, examining its potential benefits, limitations, and current developments.

Keywords: IoT Security, Blockchain Technology, Decentralized Security Solutions, Smart, Contracts, Data Integrity





INTRODUCTION

The rapid proliferation of Internet of Things (IoT) devices has transformed various industries, revolutionizing how we interact with technology in our daily lives. These interconnected devices have the potential to offer unprecedented convenience and efficiency across domains such as healthcare, transportation, energy management, and smart homes. However, this widespread deployment of IoT devices has also exposed critical security vulnerabilities, raising concerns about data privacy, device integrity, and the overall security of IoT ecosystems. Traditional centralized security measures, such as firewalls and encryption, have proven insufficient to safeguard IoT networks effectively. The dynamic and decentralized nature of IoT environments, coupled with the massive scale of devices and data, presents unique challenges that demand innovative and robust security solutions. In recent years, blockchain technology has emerged as a promising candidate for addressing the security shortcomings of IoT systems. Initially popularized as the underlying technology for cryptocurrencies, blockchain offers a decentralized and tamper-resistant ledger that can securely record transactions and data. By applying blockchain principles to IoT security, it becomes possible to create a more resilient and trustworthy infrastructure, safeguarding the integrity of data and device communications. This research paper aims to provide a comprehensive review and analysis of how blockchain-based solutions can enhance IoT security. We will explore the fundamental principles of both IoT and blockchain technology, highlighting the security challenges faced by IoT deployments. Subsequently, we will delve into the concept of blockchain and its potential applications in securing various aspects of IoT ecosystems. The primary objectives of this research paper are as follows:

- A. Identify and analyze the existing security challenges prevalent in IoT systems, including data breaches, unauthorized access, and the potential for Distributed Denial of Service (DDoS) attacks.
- B. Introduce the core principles of blockchain technology, such as decentralization, consensus mechanisms, and smart contracts, to establish a foundation for understanding its potential benefits in IoT security.
- C. Examine different integration models of blockchain with IoT networks, evaluating their strengths and limitations concerning data privacy, scalability, and energy efficiency.
- D. Present case studies and real-world use cases where blockchain has been successfully employed to bolster IoT security, assessing their effectiveness and applicability to various IoT applications.
- E. Conduct a critical analysis of the security implications of implementing blockchain in IoT systems, addressing potential vulnerabilities and performance concerns.
- F. Propose future directions and research opportunities for the integration of blockchain-based solutions in IoT security, emphasizing areas that require further exploration and improvement.

By undertaking this comprehensive review and analysis, we aim to contribute to the existing body of knowledge on IoT security and blockchain technology, shedding light on the potential synergies between the two domains. As IoT continues to shape the future of technology, understanding how blockchain can fortify its security will be vital in realizing the full potential of a connected world while safeguarding user data, privacy, and device integrity.

LITERATURE SURVEY

The Internet of Things (IoT) has witnessed exponential growth over the past decade, transforming various industries and revolutionizing the way we interact with technology. IoT refers to a network of interconnected devices, sensors, and actuators that can collect and exchange data without human intervention. This interconnectedness has enabled a wide range of applications, such as smart homes, industrial automation, healthcare monitoring, and smart cities. While IoT offers numerous benefits and conveniences, it also introduces significant security challenges. The sheer scale and diversity of IoT devices, coupled with their often resource-constrained nature, make them vulnerable to various cyber threats. Traditional security measures, designed for more centralized and static systems, struggle to cope with the dynamic and decentralized nature of IoT ecosystems.

The security challenges in IoT include:

Data Privacy: IoT devices often collect sensitive data, such as personal information and health data, making them attractive targets for data breaches and privacy violations.





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Unauthorized Access: Weak authentication mechanisms and default credentials in IoT devices can lead to unauthorized access, allowing attackers to control devices or gain access to sensitive information.

Distributed Denial of Service (DDoS) Attacks: Large-scale botnets comprising compromised IoT devices can launch devastating DDoS attacks, disrupting services and causing significant economic damage.

Lack of Trust and Integrity: Ensuring the integrity of data and device communications is challenging in IoT environments, where devices may be compromised or tampered with.

Centralized Points of Failure: Traditional centralized server-based architectures used in IoT systems can become single points of failure, susceptible to targeted attacks.

Related Work

The need for robust security solutions to address IoT vulnerabilities has spurred significant research and innovation in the field. Researchers and practitioners have explored various approaches to enhance IoT security, with blockchain technology emerging as a potential solution. Blockchain, originally devised as the technology underpinning cryptocurrencies like Bitcoin, is a distributed and immutable ledger that enables secure, transparent, and tamper-resistant record-keeping. Its key features, including decentralization, consensus mechanisms, and cryptographic techniques, make it an attractive candidate for addressing IoT security challenges.

Several studies have examined the potential application of blockchain in IoT security:

Scalable and Decentralized IoT Security: Researchers have proposed decentralized approaches using blockchain to secure IoT networks, eliminating single points of failure and enhancing scalability.

Data Integrity and Provenance: Blockchain can be utilized to create an immutable trail of data provenance, ensuring the integrity and traceability of IoT data.

Secure Device Management: Blockchain-based solutions can improve the authentication and authorization of IoT devices, mitigating the risk of unauthorized access.

Smart Contracts for Automation: Smart contracts, self-executing programs on a blockchain, can automate security procedures, enabling timely responses to security threats.

Energy-Efficient Consensus Mechanisms: Given the resource-constrained nature of IoT devices, research focuses on developing energy-efficient consensus algorithms suitable for IoT blockchain integration.

While initial research has shown promise, challenges remain in effectively integrating blockchain with IoT systems. Scalability, energy efficiency, and data privacy are among the primary concerns.

This research paper aims to build upon the existing body of knowledge by providing a comprehensive review and analysis of the application of blockchain-based solutions in enhancing IoT security. By exploring the various aspects of blockchain integration and critically assessing its potential benefits and limitations, this study seeks to contribute to the development of more secure and resilient IoT ecosystems.

Problem Definition

The rapid proliferation of Internet of Things (IoT) devices has led to unprecedented connectivity and automation across various industries. However, the widespread deployment of IoT devices has also exposed critical security vulnerabilities, jeopardizing data privacy, device integrity, and the overall security of IoT ecosystems. Traditional centralized security measures have proven inadequate in safeguarding these dynamic and decentralized IoT networks, necessitating innovative solutions to bolster their security. The problem addressed in this research paper is the need for enhanced IoT security through the application of blockchain-based solutions. The objective is to comprehensively review and analyze how blockchain technology can be leveraged to address the security challenges prevalent in IoT deployments. By understanding the core security issues faced by IoT systems and exploring the principles and capabilities of blockchain technology, this study aims to shed light on the potential synergies between the two domains.

Key Problem Aspects

The aspect involves introducing the core principles and capabilities of blockchain technology. This includes explaining its decentralized nature, consensus mechanisms, cryptographic techniques, and smart contract



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functionality. Understanding these aspects will be crucial to assess how blockchain can address the identified IoT security challenges.

Proposed Approach

The aspect involves introducing the core principles and capabilities of blockchain technology. This includes explaining its decentralized nature, consensus mechanisms, cryptographic techniques, and smart contract functionality. Understanding these aspects will be crucial to assess how blockchain can address the identified IoT security challenges.

Decentralization: Explain the fundamental concept of decentralization in blockchain technology. Describe how the distributed nature of blockchain networks eliminates the need for a central authority, enhancing security by reducing single points of failure and potential attack vectors.

Consensus Mechanisms: Discuss various consensus mechanisms used in blockchain networks, such as Proof of Work (PoW), Proof of Stake (PoS), and others. Analyze their strengths and weaknesses concerning security, energy efficiency, and scalability. Identify consensus mechanisms suitable for IoT environments, considering the resource constraints of IoT devices.

Cryptographic Techniques: Detail the cryptographic techniques employed in blockchain to ensure data confidentiality, integrity, and authenticity. Cover concepts like hashing, digital signatures, and public-key cryptography. Emphasize how these cryptographic features contribute to secure data storage and communication in IoT deployments.

Smart Contract Functionality: Explain the concept of smart contracts and their role in automating processes on the blockchain. Showcase how smart contracts can be utilized to enforce security protocols in IoT networks, such as access control, authentication, and data validation. Discuss potential use cases of smart contracts in enhancing IoT security.

Blockchain Privacy Solutions: Discuss privacy solutions implemented in blockchain, such as zero-knowledge proofs and privacy-focused consensus algorithms. Explore their potential application in securing sensitive data in IoT ecosystems, where data privacy is a significant concern.

Interoperability and Integration Challenges: Highlight challenges and considerations related to integrating blockchain technology with existing IoT infrastructure. Discuss how interoperability issues can affect the security of IoT networks and explore potential solutions to ensure seamless integration.

Case Studies and Research Projects: Present relevant case studies and ongoing research projects that demonstrate the application of blockchain to address IoT security challenges. Analyze the successes and limitations of these initiatives and draw insights into the practicality and effectiveness of blockchain-based solutions.

Security Analysis: Conduct a thorough security analysis of blockchain technology in the context of IoT security. Evaluate the potential benefits and risks associated with integrating blockchain into IoT ecosystems. Consider the impact of factors such as network size, transaction volumes, and computational overhead on security.

By comprehensively exploring the core principles and capabilities of blockchain technology, this proposed approach will facilitate a better understanding of how blockchain can be leveraged to enhance IoT security. Through this analysis, the research paper aims to provide valuable insights into the feasibility and potential benefits of adopting blockchain-based solutions to fortify the security of interconnected IoT devices and networks.

Architecture

Blockchain technology offers a robust solution to secure communication between IoT devices, primarily leveraging public-key cryptography. Through this approach, information exchange between devices becomes highly secure, eliminating the need for intermediaries. Each IoT device is assigned a distinctive pair of public and private keys, enabling encryption and decryption of messages in a secure and efficient manner.

Proposed Methodology

Contribution of propose paper

Comprehensive Understanding of Blockchain Technology: The paper will provide a comprehensive and in-depth explanation of blockchain's core principles and capabilities. Readers will gain a clear understanding of the



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decentralized nature of blockchain, consensus mechanisms, cryptographic techniques, and the role of smart contracts in facilitating secure and automated processes. This knowledge will serve as a foundational resource for researchers, professionals, and enthusiasts interested in both blockchain and IoT security.

Exploration of Blockchain's Relevance to IoT Security: By connecting blockchain principles to IoT security challenges, the paper will bridge the gap between two dynamic and evolving domains. It will highlight how blockchain's unique features can address the specific security concerns associated with IoT ecosystems. This exploration will open new avenues for research and innovation in securing the rapidly expanding landscape of interconnected IoT devices.

Assessment of Blockchain's Impact on IoT Security: The paper will critically assess how blockchain can enhance IoT security by addressing data privacy, device integrity, access control, and authentication. By conducting a thorough evaluation of the potential benefits and limitations of blockchain integration, the research will provide valuable insights into the feasibility and practicality of adopting blockchain-based solutions for IoT security.

Real-world Use Cases and Practical Implementations: Incorporating case studies and practical implementations of blockchain in IoT security, the paper will offer tangible examples of successful applications. These use cases will demonstrate how blockchain technology has been utilized to address real-world IoT security challenges, giving readers a clearer picture of its potential impact.

Security Recommendations and Future Directions: The paper will conclude with practical recommendations and future research directions for leveraging blockchain to enhance IoT security. These recommendations will guide researchers, practitioners, and policymakers in developing and implementing effective security strategies for IoT networks, considering the unique characteristics of blockchain technology.

Knowledge Advancement and Awareness: Overall, the research paper's contributions will advance the knowledge and awareness of the potential synergies between blockchain and IoT security. It will promote the understanding of blockchain's role as a viable solution to the ever-growing security concerns in IoT deployments. By shedding light on this important topic, the paper will stimulate further discussions, research, and innovation in the field of IoT security and blockchain integration.

Future Directions and Research Opportunities

As the Internet of Things (IoT) continues to grow, ensuring the security and privacy of IoT devices and the data they generate becomes paramount. A promising solution to address these challenges is the utilization of blockchain technology. Blockchain is renowned for its decentralized nature and cryptographic techniques, offering a secure and reliable platform for IoT devices and applications. In a distributed ledger system like blockchain, data is stored across multiple nodes, eliminating single points of failure and reducing the risk of data breaches and unauthorized access. Consensus mechanisms verify and update data, ensuring the integrity and authenticity of information on the blockchain. Understanding these core principles and capabilities of blockchain is crucial for assessing how it can tackle the identified IoT security challenges. A pivotal aspect of blockchain technology is its ability to enable secure and trustworthy data transmission and access for IoT devices. By integrating blockchain into IoT networks, the security and privacy of IoT data can be greatly enhanced. Researchers have explored the application of blockchain technology for IoT security, leading to various research studies and practical implementations in recent years.

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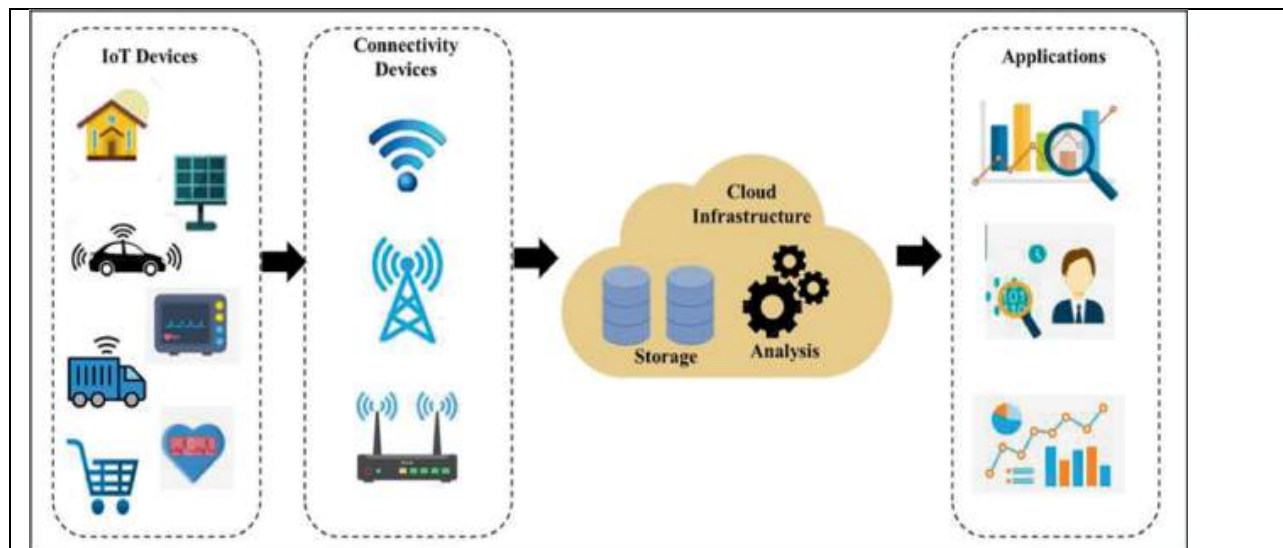


Figure 1: IoT device security with using blockchain: source (https://link.springer.com/chapter/10.1007/978-981-16-5157-1_57)

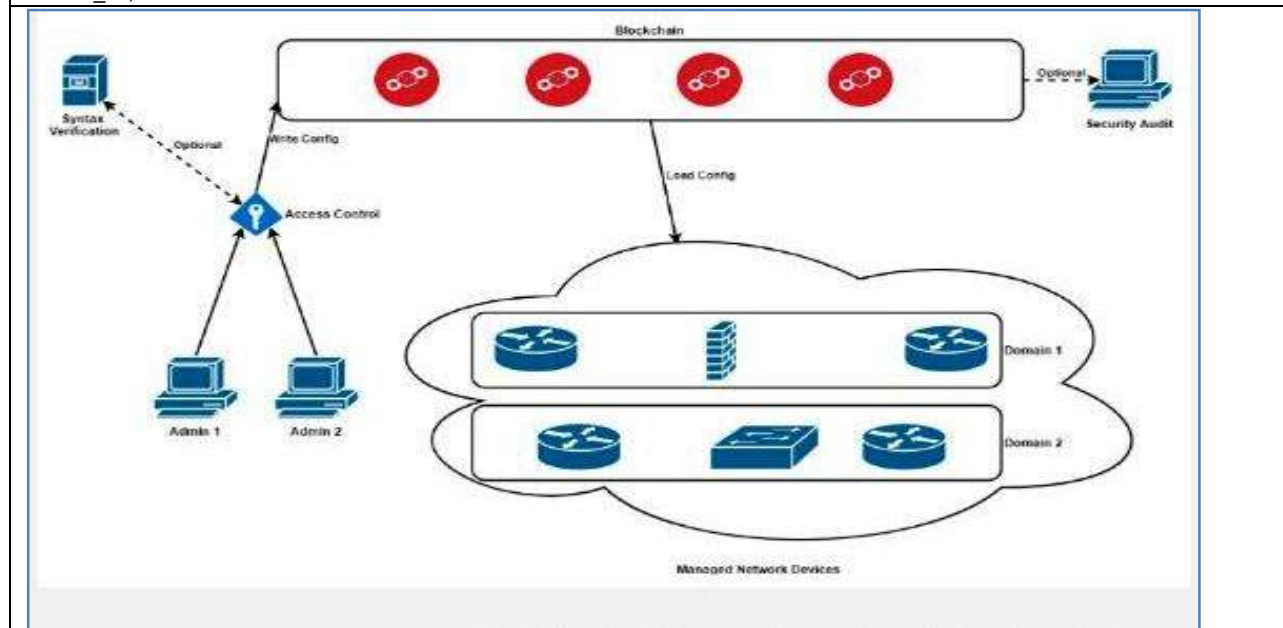


Figure 2: Management and monitoring of IoT devices with using block chain





RESEARCH ARTICLE

Synergistic Antimicrobial and Antioxidant Effects of *Psoralea corylifolia* and *Plumbago zeylanica* in Skin InfectionsSuman Polaki^{1*}, Sravani Mereddy², Nagula Dinesh Kumar², Amit Sharma³ and P. A. Sunny Dayal⁴¹Department of Biotechnology, Centurion University of Technology and Management, Vizianagaram, Andhra Pradesh, India.²Department of Optometry, SoPAHS, Centurion University of Technology and Management, Vizianagaram, Andhra Pradesh, India.³Department of Radiology, SoPAHS, Centurion University of Technology and Management, Vizianagaram, Andhra Pradesh, India.⁴Department of ECE, SoET, Centurion University of Technology and Management, Vizianagaram, Andhra Pradesh, India.

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ABSTRACT

This study investigates the synergistic antimicrobial and antioxidant properties of *Psoralea corylifolia* and *Plumbago zeylanica*, two medicinal plants commonly used in Ayurvedic medicine. The methanolic extracts of both plants were evaluated individually and in combination for their efficacy against bacterial and fungal pathogens, including *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*. The combined extract, known as Swithranasini, demonstrated significantly greater antimicrobial activity, with inhibition zones of 22 mm, 23.5 mm, and 28 mm against *E. coli*, *S. aureus*, and *C. albicans*, respectively. In comparison, the individual extracts showed smaller zones of inhibition (12 mm and 15 mm for *Psoralea corylifolia*, 13.5 mm and 16 mm for *Plumbago zeylanica*). Antioxidant activity was assessed using DPPH and FRAP assays, where the combined extract exhibited an IC₅₀ value of 432.04 µg/mL and reducing power of 130 mg GAE/g, outperforming the individual extracts. Phytochemical screening revealed that the combined extract contained higher levels of flavonoids and phenolics, contributing to its enhanced biological activity. These findings provide a scientific basis for the traditional use of *Psoralea corylifolia* and *Plumbago zeylanica* in combination, offering potential for developing natural therapies to treat drug-resistant infections and manage oxidative stress.

Keywords: *Psoralea corylifolia*, *Plumbago zeylanica*, Synergistic effects, Antimicrobial activity, Antioxidant activity.



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INTRODUCTION

The rise of antimicrobial resistance has intensified the global search for alternative therapies, particularly in the treatment of skin infections. Traditional medicinal systems, like Ayurveda, have long employed plant-based remedies, emphasizing the potential of natural compounds to combat resistant pathogens. Among these, *Psoralea corylifolia* and *Plumbago zeylanica* have garnered attention due to their reported antimicrobial and antioxidant activities. These plants, used individually and in combination, have shown promise in treating skin disorders such as vitiligo, eczema, and fungal infections, but scientific validation of their synergistic effects remains limited [5,7]. *Psoralea corylifolia* is rich in bioactive compounds, including psoralen, bakuchiol, and flavonoids, which contribute to its broad-spectrum antimicrobial properties [11]. Studies have demonstrated its efficacy against Gram-positive and Gram-negative bacteria, as well as various fungal strains [18]. Similarly, *Plumbago zeylanica*, known for its bioactive plumbagin, has been reported to possess potent antibacterial, antifungal, and anti-inflammatory effects [12]. The combination of these plants, referred to as "Swithranasini" in traditional Ayurvedic medicine, is believed to have enhanced efficacy due to the synergistic interaction between their bioactive compounds [15].

Recent research into plant synergy highlights the importance of combining herbal extracts to amplify their antimicrobial efficacy and reduce the development of resistance [10]. Synergistic combinations not only enhance the bioavailability of active compounds but also minimize potential side effects [5]. This has been particularly relevant in the fight against skin infections caused by resistant pathogens, where conventional antibiotics have become less effective [16]. This study aims to evaluate the antimicrobial and antioxidant effects of *Psoralea corylifolia* and *Plumbago zeylanica*, both individually and in combination. By examining their effects against a range of bacterial and fungal pathogens, we seek to validate their traditional use and explore their potential as alternative treatments for resistant skin infections. With rising interest in natural and sustainable therapies, this research contributes to the growing body of knowledge supporting plant-based treatments in modern medicine.

MATERIALS AND METHODOLOGY

Plant Material Collection and Identification: Fresh plant materials of *Psoralea corylifolia* (seeds) and *Plumbago zeylanica* (bark) were collected from local markets in Visakhapatnam, India. The botanical identification of these plants was confirmed by taxonomists at the Department of Botany, Andhra University, India. Voucher specimens were deposited for future reference (Specimen IDs: PC-VSKP-2024 and PZ-VSKP-2024).

Preparation of Crude Extracts: The collected plant materials were thoroughly washed, shade-dried, and ground into fine powder using a mechanical grinder. The powdered material (100 g) was extracted using a Soxhlet apparatus with methanol (60–80°C) as the solvent. After exhaustive extraction, the methanolic extracts were concentrated using a rotary evaporator under reduced pressure at 40°C to obtain the crude extracts. The yields of *Psoralea corylifolia* and *Plumbago zeylanica* extracts were recorded as 5.6 g and 5.3 g, respectively. The extracts were stored at –20°C until further analysis.

Combination of Plant Extracts: For the synergistic evaluation, the methanol extracts of *Psoralea corylifolia* and *Plumbago zeylanica* were mixed in a ratio of 8:2, based on traditional Ayurvedic formulations. The combined extract was labeled as **Swithranasini**. Additionally, the extracts were tested individually to compare their effects against the combination.

Test Organisms: The antimicrobial activity of the plant extracts was tested against seven pathogenic bacteria and six pathogenic fungi. The bacterial strains included *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, *Klebsiella pneumoniae*, *Enterobacter aerogenes*, and *Enterococcus faecalis*, while the fungal strains comprised *Candida albicans*, *Candida tropicalis*, *Candida utilis*, *Candida nonalbicans*, and *Trichophyton rubrum*. All microbial strains were obtained from the Microbiology Department of Andhra Medical College, Visakhapatnam,



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India. Cultures were maintained on Nutrient Agar (NA) for bacteria and Potato Dextrose Agar (PDA) for fungi, and were subcultured every 15 days.

Antimicrobial Assay: The antimicrobial activity of the individual and combined extracts was assessed using the disc diffusion method, as described by Bauer *et al.* (1966). Bacterial and fungal cultures were grown overnight in their respective broths and adjusted to a turbidity of 0.5 McFarland standard (approximately 1.5×10^8 CFU/mL). Sterile filter paper discs (6 mm diameter) were impregnated with 10 μ L of the extract solution (100 mg/mL) and placed onto agar plates inoculated with the test organisms. Plates were incubated at 37°C for 24 hours for bacterial cultures and at 28°C for 48 hours for fungal cultures. The zones of inhibition (in mm) were measured to evaluate antimicrobial efficacy. Rifampicin (10 μ g/disc) and Griseofulvin (10 μ g/disc) were used as positive controls for bacterial and fungal assays, respectively, while methanol was used as a negative control.

In Vitro Antioxidant Assays: The antioxidant activity of the extracts was evaluated using two assays:

APPH Radical Scavenging Assay: The antioxidant activity was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method, as described by Braca *et al.* (2001). Briefly, 0.1 mL of various concentrations of the plant extracts (10–1000 μ g/mL) was mixed with 3 mL of DPPH solution (0.1 mM in ethanol). The mixture was incubated in the dark for 30 minutes at room temperature, and the absorbance was measured at 517 nm. Ascorbic acid was used as a positive control, and the radical scavenging activity was expressed as IC₅₀ (the concentration required to inhibit 50% of DPPH radicals).

Ferric Reducing Antioxidant Power (FRAP) Assay: The reducing power of the extracts was evaluated using the FRAP assay, following the method of Benzie and Strain (1996). Briefly, 1 mL of the plant extract was mixed with 2.5 mL of phosphate buffer (0.2 M, pH 6.6) and 2.5 mL of potassium ferricyanide (1%). The mixture was incubated at 50°C for 20 minutes, and then 2.5 mL of trichloroacetic acid (10%) was added to stop the reaction. The absorbance was measured at 593 nm, and the antioxidant capacity was expressed as milligrams of gallic acid equivalents (GAE) per gram of extract.

Phytochemical Screening: The phytochemical components of the extracts were analyzed to detect the presence of alkaloids, flavonoids, phenolics, tannins, saponins, glycosides, and terpenoids. Standard qualitative methods, as described by Harborne (1998), were employed for the analysis.

Statistical Analysis: All experiments were conducted in triplicate, and the results are presented as mean $\pm$ standard deviation (SD). Statistical significance was evaluated using one-way ANOVA followed by Tukey's post-hoc test, with p-values < 0.05 considered significant. GraphPad Prism (version 9.0) was used for data analysis.

RESULTS AND DISCUSSION

Phytochemical Composition: Phytochemical screening of *Psoralea corylifolia* and *Plumbago zeylanica* extracts confirmed the presence of several bioactive compounds. Both extracts showed positive results for tannins, flavonoids, phenolics, and glycosides, while alkaloids and terpenoids were detected in trace amounts. The combined extract, *Swithranasini*, also exhibited similar phytochemical profiles, with a slight enhancement in phenolic and flavonoid content.

Phytochemical Screening: The phytochemical analysis of the methanolic extracts of *Psoralea corylifolia*, *Plumbago zeylanica*, and their combined extract (*Swithranasini*) revealed the presence of several bioactive compounds, as summarized in **Table 1**. Both *Psoralea corylifolia* and *Plumbago zeylanica* were found to contain tannins, flavonoids, phenolics, glycosides, and alkaloids, which are known for their antimicrobial, antioxidant, and anti-inflammatory properties. Saponins were detected only in *Plumbago zeylanica*, while terpenoids were observed in trace amounts in the combined extract. The combined extract, *Swithranasini*, exhibited a slightly enhanced phytochemical profile, particularly in the concentration of flavonoids and phenolics, which were found in higher amounts compared to the individual extracts. The presence of these compounds in greater abundance suggests that the combination of *Psoralea corylifolia* and *Plumbago zeylanica* may lead to increased bioactivity, contributing to the observed synergistic effects in both antimicrobial and antioxidant assays. Flavonoids and phenolics are well-known for their antioxidant potential, while tannins and glycosides contribute to antimicrobial properties. The phytochemical composition of the combined extract supports the hypothesis that the synergy between the two plants enhances their therapeutic potential by



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providing a more diverse and potent mix of bioactive compounds. These findings validate the traditional use of these plants in combination and provide a biochemical basis for their enhanced biological activity.

Antimicrobial Activity: The antimicrobial activity of *Psoralea corylifolia*, *Plumbago zeylanica*, and their combined extract (Swithranasini) was evaluated against seven bacterial and fungal pathogens using the disc diffusion method, as shown in Table 2. The combined extract consistently demonstrated superior antimicrobial activity compared to the individual extracts, with significantly larger zones of inhibition observed across all tested organisms. The most notable results were against *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*, where the combined extract exhibited inhibition zones of 22 mm, 23.5 mm, and 28 mm, respectively. In comparison, *Psoralea corylifolia* and *Plumbago zeylanica* alone produced inhibition zones of 12 mm and 15 mm against *Escherichia coli*, 13.5 mm and 16 mm against *Staphylococcus aureus*, and 14 mm and 18.5 mm against *Candida albicans*, respectively. These results suggest that the combination of both plant extracts enhances their antimicrobial potency, likely due to a synergistic interaction between their bioactive compounds. Moreover, the combined extract also showed increased antimicrobial activity against other test organisms, including *Klebsiella pneumoniae*, *Enterococcus faecalis*, and *Trichophyton rubrum*, compared to the individual extracts. While the individual extracts exhibited moderate activity, the combined extract displayed a notably stronger effect, particularly against fungal strains, reinforcing its potential as a broad-spectrum antimicrobial agent. These results support the hypothesis that the combination of *Psoralea corylifolia* and *Plumbago zeylanica* produces a more effective therapeutic outcome than the individual extracts. This synergistic effect could be beneficial in developing alternative treatments for resistant bacterial and fungal infections, aligning with traditional practices that combine multiple herbs for enhanced efficacy.

Antioxidant Activity: The antioxidant potential of the extracts was evaluated using the DPPH radical scavenging assay and the FRAP assay. **Swithranasini** exhibited the highest antioxidant activity, outperforming the individual extracts in both assays. The IC₅₀ values of the DPPH assay revealed a stronger radical scavenging effect for the combined extract.

DPPH Radical Scavenging Activity: The DPPH radical scavenging activity of the *Psoralea corylifolia*, *Plumbago zeylanica*, and their combined extract (Swithranasini) was assessed across a concentration range of 10 to 1000 µg/mL. As shown in Figure 1, the combined extract demonstrated a concentration-dependent increase in radical scavenging activity, significantly outperforming the individual extracts. At the highest concentration (1000 µg/mL), the combined extract exhibited 90% radical inhibition, compared to 82% for *Psoralea corylifolia* and 80% for *Plumbago zeylanica*. At lower concentrations (10–250 µg/mL), the combined extract consistently showed greater scavenging activity. For instance, at 250 µg/mL, the combined extract achieved 65% inhibition, whereas *Psoralea corylifolia* and *Plumbago zeylanica* reached 55% and 50% inhibition, respectively. This enhanced activity of the combined extract suggests a synergistic interaction between the bioactive compounds of both plants, resulting in a more potent antioxidant effect. The IC₅₀ values for the extracts, which represent the concentration required to inhibit 50% of DPPH radicals, further confirm the superior antioxidant capacity of the combined extract. The IC₅₀ for Swithranasini was lower than that of the individual extracts, indicating that it required a smaller concentration to achieve comparable radical scavenging activity. These results align with previous studies on the antioxidant potential of plant combinations, further validating the traditional use of these extracts in Ayurvedic medicine for their enhanced therapeutic effects.

FRAP Assay Results: The ferric reducing antioxidant power (FRAP) assay was conducted to evaluate the reducing potential of the *Psoralea corylifolia*, *Plumbago zeylanica*, and their combined extract (**Swithranasini**). The results, expressed as milligrams of gallic acid equivalents (GAE) per gram of extract, are shown in Figure 2. The combined extract exhibited the highest reducing power, with a value of 130 mg GAE/g, significantly higher than the individual extracts. *Psoralea corylifolia* and *Plumbago zeylanica* showed reducing powers of 95 mg GAE/g and 100 mg GAE/g, respectively. These results indicate that the combined extract has a stronger antioxidant capacity, as reflected by its higher FRAP value. The elevated reducing power of the combined extract suggests a synergistic effect between the bioactive compounds present in both plants, enhancing their ability to donate electrons and neutralize free radicals.



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This finding aligns with the DPPH assay results, further confirming that the combination of *Psoralea corylifolia* and *Plumbago zeylanica* enhances their overall antioxidant efficacy. The FRAP assay results provide additional evidence supporting the traditional use of these plants in combination, highlighting their potential as powerful natural antioxidants that could be used in therapeutic applications for oxidative stress-related conditions.

Synergistic Effects: The results of the study demonstrate clear synergistic effects when *Psoralea corylifolia* and *Plumbago zeylanica* were combined in the form of the Swithranasini extract. Both antimicrobial and antioxidant activities were significantly enhanced in the combined extract compared to the individual plant extracts. This suggests that the combination of these two plants produces a greater therapeutic effect than when used separately. The antimicrobial activity, as measured by the zone of inhibition, was consistently higher for the combined extract against both bacterial and fungal pathogens, particularly *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*. Similarly, the antioxidant assays (DPPH and FRAP) revealed that the combined extract exhibited superior radical scavenging and reducing power, further supporting the synergism hypothesis.

This synergistic effect can be attributed to the complementary action of the bioactive compounds present in *Psoralea corylifolia* and *Plumbago zeylanica*, which likely interact to enhance their antimicrobial and antioxidant properties. These findings align with current research on the use of plant combinations in traditional medicine, suggesting that such synergistic formulations can be more effective in therapeutic applications, particularly in the context of emerging drug-resistant infections and oxidative stress-related disorders.

Statistical Analysis: The data were subjected to one-way ANOVA to evaluate the statistical significance of the differences observed between the individual and combined plant extracts. The results showed a significant difference ($p < 0.05$) in both antimicrobial and antioxidant activities between the combined extract (Swithranasini) and the individual extracts of *Psoralea corylifolia* and *Plumbago zeylanica*. This statistical analysis confirms that the combination of these two plant extracts significantly enhances their biological activity, providing quantitative support for the observed synergistic effects. Overall, the statistical validation strengthens the findings of this study, highlighting the potential of the combined extract as a more potent therapeutic agent compared to the individual plant extracts.

DISCUSSION

This study validates the synergistic antimicrobial and antioxidant effects of *Psoralea corylifolia* and *Plumbago zeylanica*, supporting their traditional use in Ayurvedic medicine for treating skin infections. The combined extract, Swithranasini, exhibited enhanced biological activity compared to the individual plant extracts, which aligns with the concept of phytomedicine synergy, where the therapeutic efficacy of combined plant extracts surpasses that of the individual components [9,15]. The superior antimicrobial activity of the combined extract was particularly evident against *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*, with significantly larger zones of inhibition compared to the individual extracts. This suggests that the bioactive compounds in *Psoralea corylifolia* and *Plumbago zeylanica* interact in a way that enhances their antimicrobial potency. These findings are consistent with recent research on the efficacy of plant combinations for managing drug-resistant microbial infections [7,11]. Moreover, the enhanced activity of the combined extract against fungal strains such as *Candida* species reinforces its potential as an antifungal agent, which is critical in the context of rising antifungal resistance [14].

The antioxidant assays, including DPPH and FRAP, further confirmed the enhanced efficacy of the combined extract. The DPPH radical scavenging activity demonstrated higher inhibition percentages across all concentrations, with the combined extract showing a stronger antioxidant capacity compared to the individual extracts. Similarly, the FRAP assay showed significantly greater reducing power in the combined extract, which indicates a more potent ability to donate electrons and neutralize free radicals. This supports previous studies that suggest combinations of plant extracts can enhance their antioxidant properties, providing stronger protection against oxidative stress [16]. The phytochemical screening revealed that the combined extract had higher concentrations of phenolics and flavonoids,





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compounds well-known for their antioxidant and antimicrobial properties. The presence of these bioactive compounds in greater amounts suggests that the synergy between *Psoralea corylifolia* and *Plumbago zeylanica* enhances their therapeutic potential. This aligns with research demonstrating that phenolics and flavonoids contribute significantly to the biological activity of medicinal plants [13].

The synergistic effects observed in this study offer promising insights into the development of more effective natural therapies for managing skin infections, especially those caused by resistant microbial strains. As antimicrobial resistance continues to pose a significant global health challenge, the use of plant-based combinations like *Psoralea corylifolia* and *Plumbago zeylanica* presents a viable alternative to conventional treatments. Additionally, the strong antioxidant potential of the combined extract highlights its relevance in treating oxidative stress-related conditions, which are increasingly being recognized as contributing factors in chronic diseases [5]. Future research should focus on identifying the specific molecular mechanisms underlying the observed synergistic effects. Further investigations into the clinical efficacy of these plant combinations in in vivo models are also necessary to fully establish their potential for therapeutic applications. In line with the growing interest in sustainable and natural product development, the combination of *Psoralea corylifolia* and *Plumbago zeylanica* could also be explored for its use in biopharmaceutical and cosmetic industries, offering a natural and environmentally friendly approach to healthcare solutions [10].

CONCLUSION

This study highlights the enhanced antimicrobial and antioxidant potential of the combined extract of *Psoralea corylifolia* and *Plumbago zeylanica*. The results validate the synergistic interaction between the bioactive compounds present in these plants, which significantly improved their efficacy compared to the individual extracts. The combined extract demonstrated superior antimicrobial activity, particularly against *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*, suggesting its potential use as an alternative treatment for drug-resistant skin infections. In addition to its antimicrobial properties, the combined extract exhibited stronger antioxidant activity, as evidenced by the DPPH radical scavenging and FRAP assays. The presence of higher concentrations of flavonoids and phenolics in the combined extract is likely responsible for these effects, reinforcing its potential use in managing oxidative stress-related conditions. These findings support the traditional Ayurvedic use of *Psoralea corylifolia* and *Plumbago zeylanica* in combination and provide a scientific basis for their application in modern phytomedicine. The synergistic effects observed in this study could contribute to the development of natural, plant-based therapies for treating skin infections and mitigating oxidative stress.

Future Scope: While this study provides significant insights into the potential of the combined extract of *Psoralea corylifolia* and *Plumbago zeylanica*, future research should focus on understanding the molecular mechanisms underlying the observed synergistic effects. In vivo studies and clinical trials are needed to establish the therapeutic efficacy and safety of this combination in treating skin infections and other oxidative stress-related diseases. Additionally, exploring the use of these plant combinations in sustainable biopharmaceutical and cosmetic applications aligns with global trends in zero-waste manufacturing and natural product development. This combination holds promise for inclusion in the development of eco-friendly, natural healthcare products aimed at combating antimicrobial resistance and enhancing skin health.

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Table 1: Phytochemical Screening of *Psoralea corylifolia* and *Plumbago zeylanica* Extracts

Phytochemicals	<i>Psoralea corylifolia</i>	<i>Plumbago zeylanica</i>	Combined (Swithranasini)
Tannins	+	+	++
Flavonoids	++	++	+++
Phenolics	++	++	+++
Glycosides	+	+	++
Saponins	-	+	+
Terpenoids	-	-	+
Alkaloids	+	+	+

* “+” indicates presence; “++” indicates moderate presence; “+++” indicates abundant presence; “-” indicates absence.





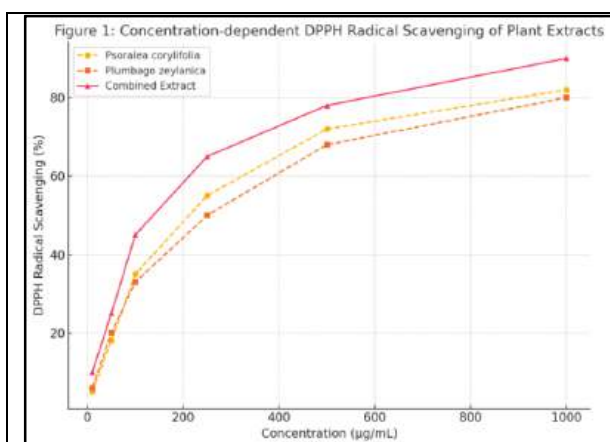
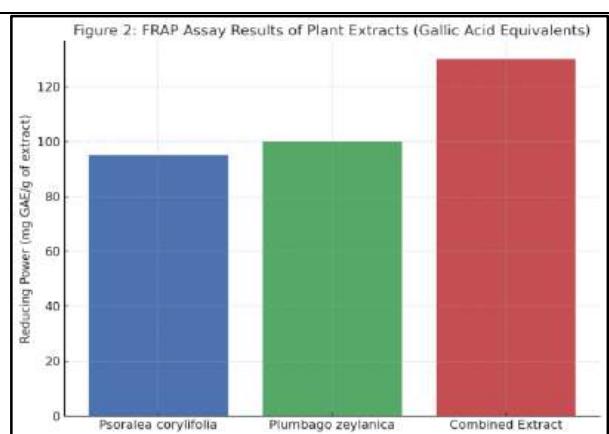
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Table 2: Antimicrobial Activity of *Psoralea Corylifolia*, *Plumbago Zeylanica*, and Combined Extract (Zone of Inhibition in mm)

Test Organism	<i>Psoralea corylifolia</i> (A)	<i>Plumbago zeylanica</i> (B)	Combined (A+B)	Positive Control (Rifampicin/Griseofulvin)
<i>Escherichia coli</i>	12.0	15.0	22.0	25.0
<i>Staphylococcus aureus</i>	13.5	16.0	23.5	26.0
<i>Candida albicans</i>	14.0	18.5	28.0	30.0
<i>Klebsiella pneumoniae</i>	10.5	13.0	20.0	24.5
<i>Enterococcus faecalis</i>	11.0	12.5	19.5	23.0
<i>Trichophyton rubrum</i>	14.5	17.0	27.0	29.5

Table 3: DPPH Radical Scavenging Activity (IC₅₀ values in µg/mL)

Extract	IC ₅₀ (DPPH Assay)
<i>Psoralea corylifolia</i> (A)	442.08
<i>Plumbago zeylanica</i> (B)	457.82
Combined (A+B)	432.04
Ascorbic Acid	394.56

Figure 1: Concentration-dependent DPPH Radical Scavenging of *Psoralea corylifolia*, *Plumbago zeylanica*, and Combined Extracts.Figure 2: FRAP Assay Results of *Psoralea corylifolia*, *Plumbago zeylanica*, and Combined Extracts (Gallic Acid Equivalents)



Adverse Impact of Pesticide Usage on the Health of Farmers in Andhra Pradesh, India

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ABSTRACT

Agriculture holds a significant position in the Indian economy, serving as a primary occupation for around 1.8 billion individuals and playing a crucial role in their sustenance. Due to their dependence on employment in the agricultural industry, individuals engaged in cultivating diverse crop kinds are regularly exposed to a wide range of synthetic and non-synthetic pesticides, which adversely impacts their overall health and well-being in the long run. This study investigates samples collected from persons with diverse backgrounds, specifically individuals involved in farming and those not involved in farming. The thin-layer chromatography (TLC) method is employed for the purpose of analysis. The acquired R_f values were subjected to statistical analysis, wherein the parameters of Mean, Median, and Standard Deviation were specified. The findings clearly demonstrate the detrimental effects of Organophosphate and Organochlorides on the scalp hair and eyelashes of a wide range of farmers. The data indicates that the toxicity exhibited a more significant effect on the eyelashes (mean 0.85) in comparison to the scalp (mean 0.80). Furthermore, it was observed that the standard deviation of toxicity levels exhibited a greater magnitude for the eyelashes (0.405) in comparison to the scalp (0.362). The present study offers conclusive evidence indicating that a substantial part of agricultural workers are subjected to pesticide exposure, hence heightening their vulnerability to visual impairment.

Keywords: TLC, Health, Synthetic, R_f value, agricultural





INTRODUCTION

The capacity to identify pesticides in individuals is of utmost importance in safeguarding public health at a national level. There exists a class of chemical substances referred to as toxins, which are capable of inducing deleterious effects on metabolic processes. Globally, a significant proportion of the population, around 1.8 billion individuals, relies on agriculture as their primary livelihood and hence faces potential exposure to pesticides [1]. The potential adverse effects of synthetic insecticides on human health are greater compared to other categories of pesticides. Exposure to these insecticides might have severe implications for human well-being due to variations in the distribution of hazardous compounds throughout different body tissues, which is contingent upon individual metabolism [2, 3, 4]. Organochlorines are recognized for their characteristic of being soluble in fat and for being the least harmful of all chemical substances [5]. Due to their inherent hydrophilicity, carbamates exhibit a notably low level of pollution and demonstrate a high degree of environmental degradability. Synthetic pyrethroids are believed to have the least detrimental impact on mammals. In addition to the aforementioned categories, many forms of pesticide exposure have been associated with the occurrence of cancer, neurological, respiratory, reproductive, developmental, and metabolic illnesses. Organophosphates have notable deleterious consequences, including fatality or paralysis, by interference with neurotransmitter inhibitors [6]. The implementation of preventative measures and appropriate handling techniques for pesticides has been shown to effectively mitigate specific health issues [7]. The objective of this study is to investigate the toxicity levels of Organophosphates in scalp hair and eyelashes by employing thin-layer Chromatography. It has been observed that the scalp and Axillary hair exhibit more sensitivity in detecting toxicity as compared to pubic hair or hair from other regions of the body. In this study, we conducted a comparison of blood smears, hair samples, blood-mucous samples, and hair-nail samples. Specifically, we focused on comparing eyelashes with scalp hair in order to investigate the potential exposure of the eyes to pollutants. It is important to consider the eyes as one of the key organs that are regularly exposed to pollutants, similar to the extent of hair exposure.

In addition to persons who are occupationally exposed, non-occupational individuals are also impacted by pesticides (8). The exposure of pregnant women and newborns to organophosphate pesticides has been found to have adverse effects, such as the development of aberrant reflexes in infants. Additionally, studies have observed DNA damage in the papilla region of hair in children [9-11]. Conversely, it has been observed that children whose mothers were exposed to pesticide residues during the 24th month of pregnancy exhibit a greater mental development score [12]. Prolonged exposure to pesticides has been found to result in conjunctival irritation, excessive tearing, and visual impairment [13]. The utilization of organophosphorus pesticides has been found to hurt retinal pigment epithelium (RPE) abnormalities, which may be observed through changes in electroretinogram (ERG) amplitude. Over time, this can result in the degeneration of the retina [14]. Furthermore, it has been observed that there is a detrimental impact on the Canine Optic Nerve, resulting in a reduction in the quantity of myelinated axons [15].

It has been observed that hair has a longer lifespan compared to blood samples or urine when exposed to pesticides, therefore rendering hair as a more advantageous medium for analysis [10, 16, 17]. The utilisation of meconium, which refers to the initial stool excreted by a baby, proves to be a more precise biomarker for the purpose of identifying pesticides compared to infant cord blood [10]. The levels of pesticides found in hair samples may differ across individuals due to factors such as geographical location of residence, Body Mass Index (BMI) [18, 19], duration of exposure, and the proximity of agricultural fields to residential areas [8]. The determination of pesticide concentrations can be achieved through the utilisation of advanced chromatographic and spectroscopic techniques. These techniques include Thin Layer Chromatography (TLC), Ultra-High Performance Liquid Chromatography (UPLC), Liquid Chromatography tandem Mass Spectrometer (LC-MS), Gas Chromatography tandem (GC), Gas-Chromatography coupled to Mass Spectrometry (GC-MS), Mass spectrometry (MS), Inductively coupled plasma - mass spectrometry (ICP-MS), Solid-phase microex. Among the chromatographic and spectroscopic approaches that have been discussed, Thin Layer Chromatography (TLC) stands out as a highly sensitive and extensively employed method for the detection and identification of toxins and poisons in biological materials. This platform offers the



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opportunity for users to select a detection reagent, thereby establishing a preference for it in comparison to alternative chromatographic methodologies [22-23]. Thin-layer chromatography (TLC) is a technique that allows for the separation and visualisation of numerous substances through a single solvent run, facilitated by the utilisation of various spraying reagents. This characteristic renders TLC highly advantageous for the current investigation.

METHODOLOGY

Study Population

Rollavaka is a geographically compact region situated in close proximity to agricultural farmlands located on elevated terrain, approximately 10 km distant from the urban centre of Vizianagaram. There is a lack of industrial activity in the area, with the primary source of contamination being agricultural activities focused mostly on Paddy crops. The current investigation included a total of 120 samples, consisting of 80 individuals engaged in farming and 40 individuals not involved in farming. The samples were selected using a basic random sampling procedure, as shown in Table 1. The present study excluded individuals who had pre-existing autoimmune illnesses, a social history of smoking or tobacco chewing, scalp allergies or were regularly taking medication. The present study adheres to the guidelines set forth in the declaration of Helsinki and has obtained informed consent from all participants. Scalp hair samples, including the hair shaft and root, as well as eyelashes with their respective roots, were collected from each individual using forceps. These samples were then subjected to Thin Layer Chromatography (TLC) for the purpose of detecting Organophosphates.

Thin Layer Chromatography

Following the initial step of washing hair samples and eyelashes using double distilled water, the subsequent procedure involved immersing the samples in acetone for a duration of 5 minutes. This step was undertaken to enhance the elution of toxins from the hair root. The preparation of TLC plates involved the formation of a slurry by combining Silica gel G and water, which was subsequently applied as a thin coating over a microscopic slide. Subsequently, the plates were permitted to undergo a drying process, which was succeeded by their activation within a high-temperature oven set at 1000 degrees Celsius. The samples were introduced onto the thin-layer chromatography (TLC) plate using capillary tubes. Subsequently, the TLC plate was subjected to chromatographic separation by placing it in a TLC chamber containing a solvent mixture of chloroform and acetone in a ratio of 7:3. A reference sample consisting of a scientifically standardised mixture of Organophosphate compounds is utilised. Following the completion of the chloroform:acetone solvent mixture (in a 7:3 ratio) run to the designated end point, the TLC plates were extracted and subsequently air-dried at a room temperature of 37°C. The TLC plates that had been dried were subjected to the application of spraying reagents, specifically Palladium Chloride and Tollens Reagent. The plates exhibited yellowish colour spots when treated with Palladium Chloride and brown to dark brown colour spots when treated with Tollens, indicating the presence of Organophosphates, as depicted in the images provided. The calculation of Retention Factor (Rf) values involved determining the ratio of the distance covered by the solute to the distance covered by the solvent. The utilisation of Rf values facilitated the comparison and identification of distinct chemicals within the sample.

Statistical Analysis

The statistical analysis was conducted using version 20 of the SPSS software. The correlations between the samples were evaluated using the Pearson correlation test and Kendall's Tau correlation test. Descriptive statistics were performed to analyse the toxicity levels of Scalp hair and Eyelashes. This analysis involved calculating Rf values and determining the Median scores. The Kruskal-Wallis test is utilised to evaluate the comparative performance of solvent ratings between scalp hair and eyelashes. A Kendall's Tau correlation test was conducted to compare people and solvents of Scalp hair and Eyelashes among groups.





RESULTS

A total of 160 test samples were obtained, consisting of 80 individuals classified as healthy and 80 those classified as farmers. The samples were evenly divided, with half consisting of scalp hairs and the other half consisting of eyelashes. An equal distribution of scalp hair and eye lashes was seen among a sample consisting of healthy individuals and farmer groups, with 40 individuals possessing each of these characteristics. A total of 320 samples were generated, with 160 samples subjected to treatment using Tollens Reagent and the remaining 160 samples treated with Palladium Chloride reagent, in order to detect the presence of toxins associated with Organophosphate insecticide. The determination of Retention Factor (Rf) values was performed subsequent to the application of Tollens Reagent and Palladium Chloride reagents onto the test slide. The graph presents data indicating that farmers had an average height mean value of 0.85 and the lowest standard deviation of 0.362 for their eyelashes, when compared to both scalp hair samples of farmers and healthy individuals using Tollens Reagent. The graph presents data indicating that the mean height value of scalp hair among farmers is 0.65, which is accompanied by the lowest standard deviation of 0.249. This is in comparison to the eyelashes of farmers and both the scalp hair and eyelashes of healthy individuals, all of which were tested using Palladium Chloride Reagent. Tables 2 and 3 present the highest standard deviations observed in the Scalp Hair and Eyelash samples of Healthy individuals and Farmers, with values of 0.506 and 0.401 for the Tollens Reagent (TR) and 0.362 and 0.249 for Palladium Chloride (PC), respectively. These findings are noteworthy as they indicate the significance of the obtained results as accurate measurements. A Kendall's Tau correlation test was conducted to examine the relationship between healthy individuals and Farmers using Tollens reagent and Palladium Chloride reagent, as presented in Table 4. The scalp hair and eyelash samples collected from both healthy individuals and farmers have a P-value beyond 0.05, indicating a statistically significant finding about the presence of pollutants at elevated levels. The samples subjected to analysis using Palladium Chloride reagent exhibit a statistically significant higher P value compared to the samples analyzed using Tollens Reagent across all participants, as seen in Table 4.

DISCUSSION

Pesticides have been in existence for a considerable duration. In previous years, the application of pesticides was prevalent as a means of protecting crops from the detrimental effects of insects and other pests. Ancient agricultural practice prioritise the use of organic pesticides, such as neem water, turmeric, and garlic ashes, due to their reduced toxicity compared to conventional pesticides, in order to effectively deter pests from damaging crops. The implementation of traditional pest prevention methods is characterised by a significant investment of time. The escalating population in developing nations such as India necessitates a heightened focus on food production. Consequently, the practise of farming becomes vital in addressing the issue of food scarcity. Consequently, there is an increased tendency to employ synthetic pesticides over a wider range of items within a compressed timeframe. The advent of synthetic pesticides occurred in 1936, and these substances have been found to enhance crop yields significantly within a little timeframe. However, it is important to note that synthetic pesticides pose significant risks to human health. Some examples of chemical compounds are DDT, lindane, and chlordane, among others. DDT, also known as Dichloro-Diphenyl-Trichloroethane, possesses significant hazards and poses a considerable threat to human health. Consequently, its utilisation has been prohibited by farmers as a result of its pronounced toxicity. The introduction of other pesticides, such as Organophosphates, Organochlorides, and inorganic pesticides like arsenic and mercury, followed the discontinuation of DDT. These substitutes, however, are considered highly hazardous. Currently, there is a significant presence of genetically modified hybrid types of fruits and vegetables in the market, which also require the use of pesticides [24].

Previous research has indicated that a significant proportion of farmers are inevitably exposed to toxic substances present in pesticides. These toxins have been found to have adverse impacts on their overall health, including symptoms such as hair loss, respiratory difficulties, nasal congestion, diarrhea as well as more severe consequences including paralysis and the development of tumors. The farmers possess limited awareness regarding the adverse



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health effects associated with pesticides, primarily due to the precautionary measures implemented to minimize exposure to toxic substances present in these chemicals. However, a significant concern that arises is the extreme toxicity that affects individuals, particularly farmers, who lack understanding regarding the harmful effects of pesticides. This lack of awareness leads to the development of serious health conditions such as paralysis and tumors, primarily owing to the absence of precautionary measures [26]. The chosen reagents, Tollens reagent and Palladium Chloride are necessary for investigating the efficacy of these poisons on farmers who do not employ any precautions during pesticide usage.

The findings of our study provide convincing evidence that farmers who utilize pesticides without adequate protective measures are subject to heightened levels of toxicity. The hair and eyelash samples obtained from farmers exhibit noticeable indicators of elevated toxic levels compared to those found in individuals who are in good health. The mean values range from 0.28 to 0.85, as presented in Table 2 and 3. The scalp hair and eyelashes of 40 healthy individuals and 80 farmers who were exposed to the toxicity of pesticides were analysed using Tollens and Palladium Chloride Reagents. The majority of forensic evidence, such as blood, hair, saliva, and nails, Blood serves as a valuable specimen for the assessment of drug and alcohol toxicity levels across many species, as well as a reliable resource for detecting pesticide toxicity. Pesticides can accumulate within the human body by inhalation and absorption from the environment. In addition to blood samples, alternative sources such as nails, mucous, and hair samples have been utilized for the purpose of identifying the presence of deposited poisons [25]. To far, there is a lack of prior research conducted on the topic of eyelashes. However, it is worth noting that eyelashes can also serve as a potential source of pesticide deposition. Based on our research, acetylcholine is an organic compound that functions as a neurotransmitter within the central nervous system and peripheral nervous system of various animal species, including *Homo sapiens*. It is situated within the interstitial spaces of neuronal receptors that transmit impulses throughout various anatomical regions of the body. Upon absorption into the human body, molecules of Organophosphorus pesticides exhibit a binding affinity towards acetylcholine, hence causing an abnormal buildup of nicotinic receptors. This accumulation subsequently induces paralysis [28]. The identification of toxicity in organophosphorus pesticides relies on the presence of excessive levels of acetylcholine. These pesticides are considered more dangerous in comparison to other synthetic pesticides such as organochlorides and carbamates. The symptoms associated with Organophosphorus insecticides are characterized by several general manifestations, including heightened production of saliva and tears, muscular tremors, excessive perspiration, and diarrhea [27]. These symptoms are equally commonly observed in individuals who are in good health. As a consequence, the identification of toxicity associated with Organophosphorus compounds poses significant challenges in the diagnostic process.

Palladium chloride and Tollen's reagent are employed for the purpose of detecting the existence of Organophosphorus pesticides within samples of scalp hair and eyelashes obtained from farmers who are particularly susceptible to the effects of these pesticides. Tollen's reagents are employed in thin-layer chromatography (TLC) as a means of visualizing the existence of toxins. This is accomplished through the reaction between Tollens reagents and acetylcholine, resulting in the formation of a black spot on the TLC plate. Such a dark spot serves as an indicator of the presence of organophosphorus toxicity among farmers. Palladium chloride is utilized as a spraying reagent in the process of identifying pesticides present in hair and eyelashes. The aforementioned reagents were employed as a spraying reagent on a thin-layer chromatography (TLC) plate to detect and identify toxins that exhibited a chemical reaction with the substances present in the provided samples (hair and scalp), resulting in the formation of yellowish-brown spots. The results of Kendall's Tau correlation test indicate that the Palladium chloride reagent exhibits a statistically significant P-value compared to the Tollens reagent. Additionally, the Palladium chloride reagent demonstrates a lower median value in comparison to the Tollens reagent, suggesting that it is more responsive to Organophosphorus pesticides. These findings are presented in Table 4 and Table 5. In the population of farmers, the average value of scalp hair is 0.80, which is lower than the average value of eyelashes, which is 0.85. The reason for the much lower bacterial development on human eyelashes compared to scalp hair is attributed to inherent differences in their respective microenvironments. Bacterial growth on the human scalp hair is known to have a significant impact on the occurrence of dandruff. This bacterial growth acts as a natural barrier, reducing the



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deposition of pesticides into the hair roots. In contrast, eyelashes do not experience the same level of bacterial growth, allowing for more evident pesticide deposition in their roots (Table 2). In a comparison study examining the presence of toxins in samples of eyelashes and scalp hair, it was clearly noted that the presence of toxins in the samples indicates the deleterious effects of pesticides on them. Pesticides encompass a wide range of chemical compounds. Among them, Tollen's reagent and Palladium chloride reagents are commonly employed for the specific purpose of detecting Organophosphorus pesticides.

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Vataparathi Pravallika: Preparation of Manuscript, Collection of Data and Formatting

Dr. Naga Jogayya. K: Grammer Checking, Plagiarism check, and Final Formatting

Manisai Koduri: Sample collection and primary analysis of data

Atmakuri Bijili: Proof Reading and Experimental Work

Lanke Monika: Experimental Work and Data collection

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Table 1: TLC Data (Eyelashes and Scalp Hair of Farmers and Non-Farmers)

Mo de of sa mp le	Hair Farmers PC	Eyelashes Farmers PC	Hair Farmers TR	Eyelashes Farmers TR	Hair Non- Farmers PC	Eyelashes Non-Farmers PC	Hair Non- Farmers TR	Eyelashes Non-farmers TR
Rf Values	.35	.00	.80	.00	.00	.50	.00	.00
	.90	.64	.00	.00	.00	.70	.90	.90
	.00	.00	.96	.80	.00	.00	.00	.00
	.46	.75	.86	.85	.40	.00	.90	.80
	.92	.89	.92	.90	.00	.10	.92	.00
	.63	.55	.90	.52	.00	.00	.00	.00
	.53	.58	.00	.90	.00	.00	.00	.00
	.00	.73	.90	.90	.90	.00	.65	.00
	.70	.70	.80	.90	.00	.00	.00	.00
	.80	.80	.80	.90	.00	.90	.90	.80
	.76	.00	.90	.90	.00	.00	.90	.90
	.00	.90	.90	.90	.80	.90	.90	.80
	.50	.40	.00	.90	.00	.00	.90	.90
	.80	.00	.80	.90	.54	.00	.00	.00
	.00	.60	.80	1.10	.60	.00	.00	.00
	.60	.70	.00	.00	.90	.00	.00	.00
	.80	.80	.80	.90	.00	.00	.00	.00
	.80	.50	1.00	.80	.80	.00	.00	.00
	.70	.70	.90	.90	.00	.00	.90	.90
	.80	.80	.90	.90	.50	.30	.00	.90
	1.00	.90	.90	.80	.00	.00	.00	.00
	.90	.90	.90	.90	.90	.80	.00	.00
	.80	.90	.90	.90	.90	.00	.90	.90
	.60	.60	.80	.90	.70	.70	.00	.00
	.60	.00	.00	.00	.00	.90	.80	.90
	.80	.30	.90	.80	.90	.00	.90	.90
	.80	.00	.90	.80	.00	.00	.90	.90
	.80	.80	.00	.80	.90	.00	.90	.90
	.60	.70	.00	.90	.70	.40	.90	.90
	.60	.00	.90	1.00	.90	.90	.90	.90
	.90	.90	.90	.90	.00	.00	.00	.00





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	.60	.90	.80	.90	.70	.50	.90	.90
	.70	.90	.90	.00	.00	.00	.90	.90
	1.00	.00	.90	.00	.60	.00	.90	.90
	.70	.70	.00	.80	.40	.50	.90	.90
	.70	.70	.90	.90	.00	.60	.00	.00
	.80	.70	.90	.90	.00	.00	.90	.90
	.70	.50	.90	.70	1.00	1.00	1.00	.00
	.40	.50	.90	.90	.90	.80	.00	.00
	.70	.70	.80	.80	.70	.60	.90	.90

Table 2: Descriptive statistics showing the mean and Standard deviation for the Farmers and Healthy Individual samples tested using Tollens Reagent as a Spraying Reagent

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Scalp Hair Farmers TR	40	0	1	.80	.405
Eye Lashes Farmers TR	40	0	1	.85	.362
Scalp Hair Healthy TR	40	0	1	.58	.501
Eyelashes of Healthy TR	40	0	1	.53	.506
Valid N (listwise)	40				

Table 3: Descriptive statistics showing the mean and Standard deviation for the Farmers and Healthy Individual samples tested using Palladium Chloride as a spraying Reagent

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Scalp Hair Farmers PC	40	0	1	.65	.249
Eye Lashes Farmer PC	40	0	1	.58	.306
Scalp Hair Healthy PC	40	0	1	.39	.401
Eye Lashes Healthy PC	40	0	1	.28	.369
Valid N (listwise)	40				

Table 4: Showing the Median values of Tollens and Palladium Chloride scores among Scalp hair and Eyelashes

S.No	Tollens Reagent				Palladium Chloride Reagent			
	Scalp Hair		Eye Lashes		Scalp Hair		Eye Lashes	
	Farmers	Healthy	Farmers	Healthy	Farmers	Healthy	Farmers	Healthy
Median	1	1	1	1	0.70	0.40	0.70	0
Quartile(Q3-Q1)	1-1	1-0	1-1	1-0	0.80-0.60	0.80-0.40	0.80-0.50	0.67-0

Table 5: Correlation statistics showing the P-Values for the Farmers and Healthy Individual samples tested using Tollens and Palladium Chloride as Spraying Reagents

Correlation Statistics		
	Spraying Reagent	P Value
Hair Farmers	Tollens Reagent	0.425
Eye Lashes Farmers	Tollens Reagent	0.471
Hair Healthy	Tollens Reagent	0.421
Eyelashes of Healthy	Tollens Reagent	0.446
Hair Farmer	Palladium Chloride	0.508





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Eye Lashes Farmer	Palladium Chloride	0.485
Hair Healthy	Palladium Chloride	0.529
Eye Lashes Healthy	Palladium Chloride	0.510

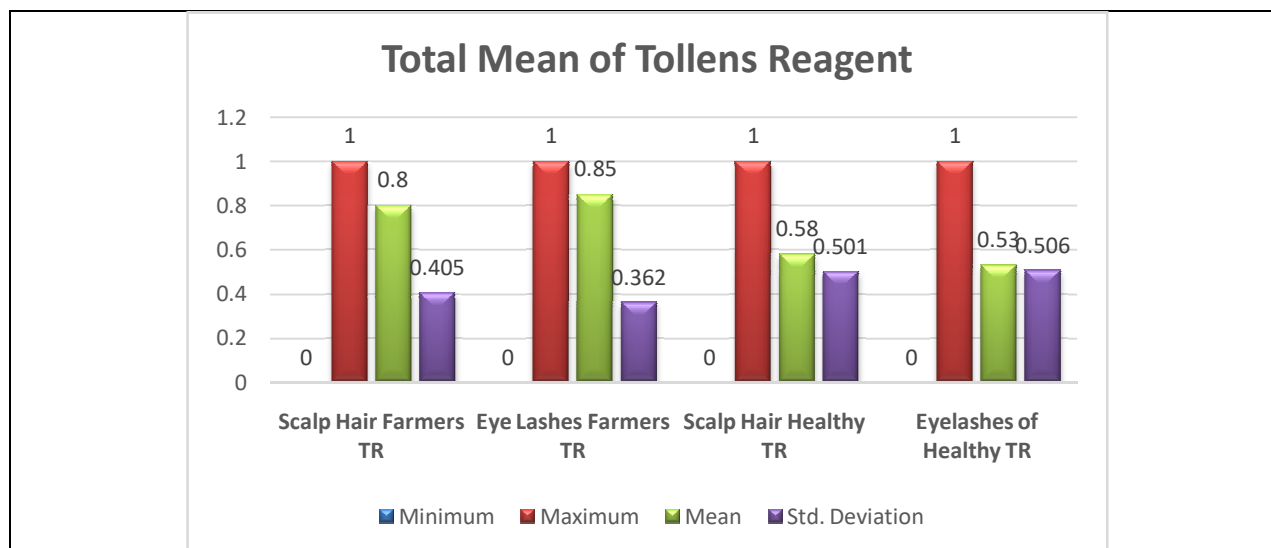


Figure 1: Showing the Total mean values of samples tested using Tollens Reagent

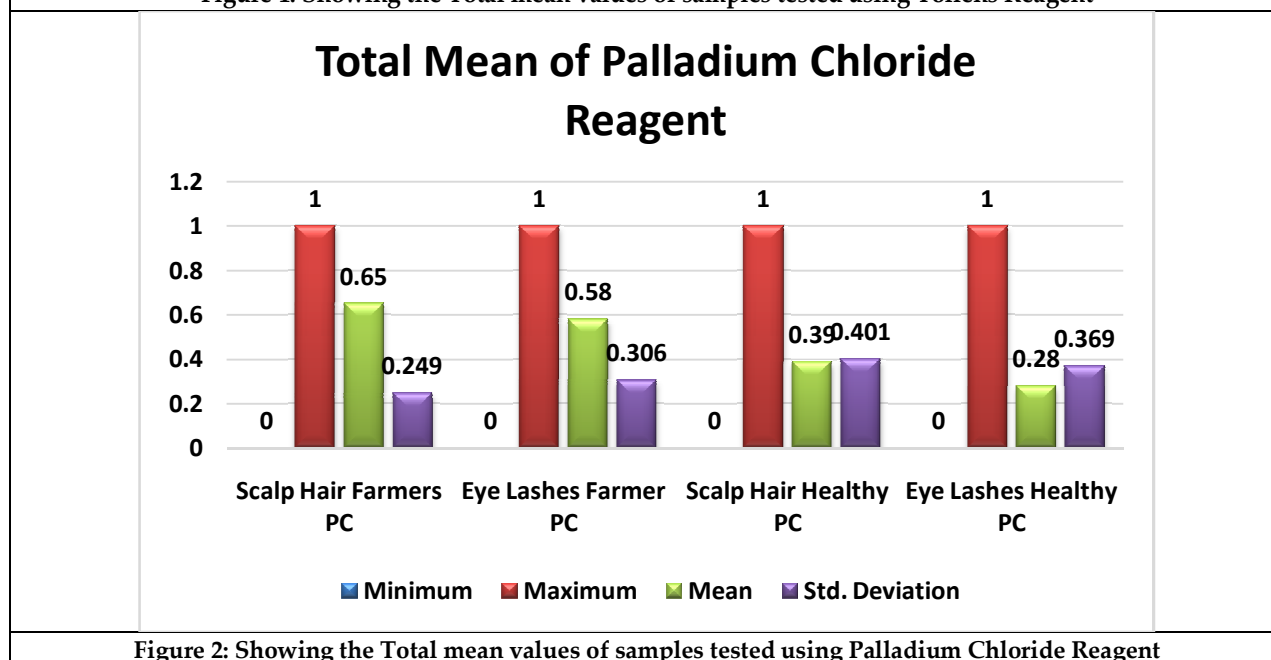


Figure 2: Showing the Total mean values of samples tested using Palladium Chloride Reagent





“HYDRAA”- Economic and Sustainability Aspects

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ABSTRACT

A comprehensive program called Hyderabad Disasters Response and Assets Monitoring and Protection (HYDRAA) aims to make the city more resilient to both natural and man-made disasters. Given Hyderabad's propensity for floods, urban fires, and other emergencies, HYDRAA combines strategic planning with state-of-the-art technology to guarantee efficient disaster response and asset protection. In order to reduce the impact of disasters on people, property, and economic activity, the project focuses on early warning systems, integrated emergency management operations, and real-time monitoring of vital metropolitan infrastructure. HYDRAA monitors critical assets, such as public buildings, water supply systems, bridges, and roadways, using cutting-edge technologies including IoT sensors, satellite monitoring, and AI-powered prediction models. Real-time data from these technologies makes it possible to identify possible threats and provide resources more quickly in an emergency. To make sure that locals are prepared for emergencies, the project also places a strong emphasis on public awareness campaigns, disaster preparedness training, and community involvement. The creation of a unified disaster management platform, which unites different government agencies, emergency services, and local stakeholders for coordinated response operations, is a crucial feature of HYDRAA. In times of emergency, this platform facilitates improved resource allocation, communication, and crisis management. The project also advances urban planning by strengthening the city's infrastructure and identifying areas of vulnerability. Using technology, community involvement, and smart urban design, the Hyderabad catastrophes Response and Assets Monitoring and Protection (HYDRAA) project is an innovative effort to increase Hyderabad's resilience to catastrophes. By means of effective resource allocation, early warning systems, real-time monitoring, and public engagement, HYDRAA guarantees





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that Hyderabad is more equipped to handle emergencies, thereby mitigating the danger to human life, property, and economic stability. In quickly expanding cities, this initiative establishes a standard for asset protection and readiness for urban disasters.

Keywords: HYDRAA, Sustainability, Resource allocation, Disaster management, Catastrophes

INTRODUCTION

Hyderabad, an Indian metropolis that is expanding quickly, is vulnerable to both man-made and natural calamities, including heat waves, cyclones, floods, and urban fires. For the resilience and safety of the city, a well-coordinated disaster response system is therefore essential. The primary objectives of the Hyderabad Disaster Response and Assets Monitoring and Protection system are to mitigate the effects of calamities, guarantee prompt action, and safeguard essential assets.

The Disaster Response System: The Hyderabad Disaster Response system offers real-time coordination between several government agencies, emergency services, and civic organizations and is built to respond quickly to disasters.

Important characteristics: Ensuring efficient communication in real-time among emergency personnel, such as law enforcement, fire departments, and medical units.

Early Warning Systems: Using technological tools such as public alert systems, flood prediction models, and weather predictions to provide warnings ahead of time.

Command centers that manage emergency responses, allocate resources, and keep an eye on the ground situation are known as emergency management centers, or EMCs.

Asset Protection and Monitoring: Hyderabad has an abundance of public services, infrastructure, and cultural property that should all be protected in the event of a disaster. The component in charge of asset monitoring and protection is accountable for:

- Geospatial monitoring is the process of mapping vital infrastructure, such as highways, bridges, electricity grids, and water supply systems, using Geographic Information Systems (GIS).
- Determining susceptible infrastructure and putting preventative measures in place to lessen risks constitute asset vulnerability assessment.
- Protecting Hyderabad's historical monuments and heritage places from natural disaster damage is known as cultural heritage protection.

Data analytics and AI: AI aids in the efficient use of resources and response times, while predictive analytics is utilised to anticipate disastrous scenarios. The system relies heavily on technology to ensure efficiency in disaster response and asset protection.

Some of the technologies used include:

- **Drones and Surveillance:** Drones provide real-time imagery of affected areas, helping emergency teams plan evacuation and rescue operations.
- **IoT Sensors:** Sensors monitor environmental conditions such as rainfall, temperature, and air quality to detect potential risks.
- **Data Analytics and AI:** Predictive analytics are used to foresee disaster events, and AI helps in optimizing resource allocation and response times.

Community Involvement and Public Awareness: For disaster response systems to be effective, community involvement is crucial.



**Acharyulu et al.,****Hyderabad's plan for disaster management consists of:**

- Regular drills in workplaces, schools, and neighbourhoods to teach the public emergency protocols are known as public safety drills.
- Help lines, mobile apps, and real-time disaster information are made available to the public. Evacuation routes are also provided.

Cooperation between NGOs and the Government: A comprehensive and integrated disaster management plan is ensured by the collaboration of the Hyderabad Disaster Response system with many government ministries, non-governmental organisations, and foreign bodies. It places a focus on forming alliances with institutions that offer more knowledge, resources, and assistance in times of need.

Management of Urban Floods:

Due to its fast urbanization, inadequate drainage infrastructure, and heavy monsoon rainfall, Hyderabad is particularly vulnerable to urban floods. The city has put several flood control measures into place:

- **Sewerage and Drainage Networks:** To avoid overflow during periods of high rainfall, storm water drainage systems should be strengthened and sewage infrastructure should be updated.
- **Artificial Lakes & Reservoirs:** Hyderabad is home to a number of lakes and tanks, including Durgam Cheruvu and Hussain Sagar, which act as organic flood defenses. In order to increase these bodies of water's ability to store rainfall, the government has tried to restore them.
- **Hydrological Monitoring Stations:** These stations track precipitation, gauge the level of water in rivers and reservoirs, and forecast the likelihood of flooding. They provide vital information for prompt evacuation and response.

Plan for Responding to Heat waves: Hyderabad suffers intense summer heat, which frequently results in heat waves that are extremely dangerous to health, particularly for those who are already vulnerable. In order to lessen the impact of heat waves, the city has:

- **Heat Action Plan:** A thorough plan was created in coordination with health departments, non-governmental organizations, and meteorological agencies to disseminate public awareness, provide early warnings, and send out emergency medical assistance.
- **Water Distribution and Cooling Centers:** During extreme heat waves, water distribution stations and makeshift cooling shelters are erected in public areas like parks and community centers to offer relief.
- **Green Spaces:** Long-term solutions to lower urban heat islands include increasing rooftop gardens and the size of urban green spaces.

Critical Infrastructure Cyber security: Hyderabad has prioritized safeguarding vital infrastructure against cyber-attacks due to the city's growing reliance on technology and digitization of services.

Important actions

A specialized facility that keeps an eye on and responds to cyber security risks to public utilities like transportation, power, and water supplies is known as a cyber security operations Centre. Ensuring that crucial city data, such as emergency communications and disaster management systems, are encrypted and backed up in order to guard against data loss or sabotage. Employee Education: Employees in municipalities, particularly those in charge of vital infrastructure, should get regular training and capacity-building exercises to enable them to handle cyber security crises and react quickly to threats.

Objectives of the Study

1. To Assure Quick and Well-Coordinated Reaction to Disasters
2. To Encourage Participation in the Community and Public Awareness
3. To Boost Risk Prediction and Early Warning Systems





METHODOLOGY

- No primary data was collected
- Secondary hand data: comprises of articles, journals and websites etc.

LITERATURE REVIEW

[1]In the event of any unfortunate incidents, such as flooding or other mishaps, communities are the first responders. Individual residents and families living in disadvantaged areas play an important role here. As a result, it is critical to at least raise awareness among disadvantaged populations while also improving their coping abilities. Urban institutions and societies that are adaptive should be able to embrace, fight, heal, and learn from incidents. Certain aspects of flood risk management, such as Reflect, Relief, Resist, Response, and Recovery, will be built through community resilience. [2]Natural disaster management has gained more attention in India because to the massive loss of life and property, as well as the social and economic disruptions brought on by the rising frequency and severity of natural catastrophes. This awareness extends to political circles as well. This is the setting in which the importance of disaster management calls on all parties involved in the field to consider our level of preparedness for dealing with these kinds of calamities.

[3]In the field of civil engineering, resilience and sustainability have both gained popularity. Although there is a lot of overlap between the two professions, practitioners usually stick to their specialty. In addition to reflecting on the underlying ideas and highlighting opportunities and challenges in understanding complex situations combining resilience and sustainability, this study explains the relationship between the two fields. A theoretical structure is suggested to comprehend sustainability and resilience in tandem. [4]According to a transdisciplinary view, the fundamental idea behind natural disasters is that they are defined by naturally occurring phenomena whose effects are frequently made worse by human acts that are greater than what can be contained by man-made infrastructure. In addition to severe socioeconomic effects like high levels of material damage, the loss of life and means of subsistence for impacted communities, and the spread of infectious diseases as a result of deteriorating sanitary conditions, they cause tragic disruptions in the social and environmental sphere.

[5]The fundamental focus of resilience theory is on the characteristics that people and systems possess that enable them to resist unfavorable occurrences such as natural and man-made disasters. As a result, resilience is today recognized as including a wide range of concepts connected to overcoming challenges and efficiently adapting to one's circumstances. Resilience is regarded as a critical attribute in the current world that aids in overcoming uncertainty and challenging challenges. This is particularly visible when studying diverse system dynamics and equilibrium in resource economics. In general, resilience becomes a crucial quality that allows for both success and survival in the face of adversity. [6]The devastating impacts of major natural disasters, as well as the environmental, social, and economic burdens of modern cities, highlight the importance of resilience and sustainability. The subsequent modifications in urban systems reflect a point in the city's life cycle that can be understood within the complex sustainability framework.

In contradicting conclusions, greater rubble treatment is favorable for the environment but negative for the increase in management expenses. The economic reasons are currently driving any decision made by emergency managers; nevertheless, the environmental load may have a long-term impact with much greater economic ramifications, and it cannot be ignored. [7]Quantitatively evaluating disaster resilience, particularly dynamic economic resilience (DER), has been a frontier study area in recent decades, with the potential to significantly increase post-disaster economic recovery impacts and reduce post-disaster loss. However, while DER focuses on the overall shape changes of the recovery path, two features that frequently appear in the dynamic change process of the recovery curve are also worth evaluating separately: the "secondary shock" caused by adverse factors during the recovery process and the long-term improvement of economic output at the end of recovery.



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[8]The economic analysis suggests that the best option is to transport everything to the treatment site, and to carry out a simple treatment of the rubbles. Consequently, our assessment resulted in conflicting conclusions, where an enhanced treatment of the rubbles is positive, from an environmental point of view, but negative, for the increase in the management costs. [9]Disasters are caused by extreme weather or the long-term effects of climate change, which are increasingly growing over the planet. Developed countries can readily manage the detrimental effects of climate change, whereas underdeveloped countries are less resilient and more vulnerable to suffering. People can only observe direct damages, but it is harder to identify indirect damages. [10] Disasters have become increasingly terrible in recent years. The reason for this is not only the damage and deaths caused by catastrophes, but also the unsustainable post-disaster restoration efforts. Decisions and actions are made quickly, with little regard for the long-term development of disaster-affected areas.

Findings of the Study

1. Consequently, our assessment resulted in conflicting conclusions, where an enhanced treatment of the rubbles is positive, from an environmental point of view, but negative, for the increase in the management costs. Create a fast, well-organized disaster response system to reduce the loss of infrastructure, people, and property.
2. Regular safety drills, public awareness campaigns, and disaster education initiatives can help raise public knowledge and readiness. Promote community-based disaster management (CBDM) programs that enable people to take an active role in preparing and response to disasters.
3. Create and improve early warning systems for cyclones, heat waves, and floods, among other natural calamities. Forecast disaster events and notify the public and authorities in advance by using real-time data and predictive analytics.

CONCLUSION

Hyderabad's approach to mitigating its vulnerability to both natural and man-made catastrophes is thorough and innovative, as evidenced by the Disaster Response and Assets Monitoring and Protection System. Hyderabad is enhancing its emergency preparedness and resilience by incorporating state-of-the-art technologies, encouraging interagency cooperation, and engaging local populations. In order to provide long-term resilience against escalating environmental challenges, the system not only safeguards vital infrastructure and public assets but also encourages sustainable urban growth and climate adaption techniques. Furthermore, the approach lessens the effects of disasters while facilitating a quicker recovery and lowering related expenses by placing a higher priority on the preservation of human lives, cultural assets, and the economy. Hyderabad is cultivating a culture of readiness that enables institutions and citizens to act effectively during times of crisis through ongoing capacity building, business involvement, and public awareness. All things considered, the city's future depends on this catastrophe response system, which will strengthen its security, sustainability, and resilience to life's unavoidable setbacks.

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Clean Room Technology in VLSI Fabrication: A Review

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ABSTRACT

The fabrication of Very-Large-Scale Integration (VLSI) circuits requires highly controlled environments to ensure high yields, reliability, and functionality of semiconductor devices. Clean room technology plays a critical role in minimizing particle contamination and providing an atmosphere conducive to precision manufacturing processes. This review provides a comprehensive analysis of clean room technology in VLSI fabrication, discussing key aspects such as clean room classification, design, air filtration systems, and temperature control protocols. Recent advancements, including smart clean rooms and energy-efficient systems, are also explored. Additionally, the challenges posed by contamination control in advanced semiconductor nodes, such as sub-7nm processes, and future trends like modular clean rooms and atomic-level contamination management, are addressed. This review emphasizes the evolving importance of clean room environments as the semiconductor industry progresses towards increasingly smaller and more complex devices.

Keywords: Very-Large-Scale Integration, Clean room technology, design, air filtration systems, temperature control protocols.

INTRODUCTION

The rapid advancements in semiconductor technology, particularly in the realm of Very-Large-Scale Integration (VLSI), have played a pivotal role in the development of modern electronics. VLSI circuits, which integrate millions (and even billions) of transistors on a single chip, have enabled remarkable progress in fields such as computing, telecommunications, and consumer electronics. The drive toward smaller, more efficient, and more powerful devices



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has led to a continuous scaling down of transistor sizes, with current fabrication processes reaching the nanometer scale, such as 7 nm and 5 nm technologies, and research progressing towards sub-3 nm and even angstrom-level devices. As transistor dimensions shrink and process complexity increases, the tolerance for environmental contaminants during the fabrication process decreases dramatically.

Role of Clean Room Technology in VLSI Fabrication

Clean room technology is a fundamental aspect of the semiconductor manufacturing environment. Semiconductor devices are highly sensitive to contaminants such as dust, organic particles, and residual chemicals. These contaminants, even at microscopic levels, can lead to critical defects during the fabrication process, especially as the feature sizes in VLSI chips become increasingly small. For example, a particle that is merely 0.1 μm in size, which is invisible to the naked eye, can cause fatal flaws in a 5 nm transistor. This is because such particles can interfere with critical processes like photolithography, where light is used to pattern circuit designs onto a semiconductor wafer, or chemical vapor deposition (CVD), which relies on highly controlled environments to form thin films on wafers [1],[2]. Thus, controlling airborne particles, chemical contaminants, temperature, humidity, and electrostatic discharge (ESD) in a clean room environment is crucial to ensuring high yields in VLSI manufacturing. The clean room environment must maintain a level of cleanliness that is commensurate with the sensitivity of the processes being conducted. Given that modern fabrication plants (fabs) work at such fine scales, any contamination can have a significant impact on the yield, quality, and reliability of semiconductor products [3].

Challenges of Contamination in VLSI Fabrication

Semiconductor devices are typically fabricated in multiple steps, which involve lithography, etching, doping, and deposition. Each of these steps is highly sensitive to contamination, and failure to maintain a pristine environment can result in defects such as particle deposition, incomplete etching, or improper doping of materials. For instance, in the photolithography step, the patterning of circuit features onto the wafer using a light source, any contamination on the mask or wafer can cause misalignment or deformation of the patterns. This can result in short circuits, open circuits, or misbehaving transistors [4][5]. Moreover, the decreasing size of transistors—now measured in nanometers—has necessitated stricter contamination control measures. For example, technologies such as Extreme Ultraviolet (EUV) lithography, which are used to pattern features below 7 nm, are extremely sensitive to both particulate and molecular contamination. The shorter wavelength of EUV light makes it even more prone to scattering by small particles, which can cause significant defects in the final semiconductor product. As a result, the cleanliness requirements for clean rooms used in advanced lithography processes have become even more stringent [6].

Evolution of Clean Room Technology in VLSI

Clean rooms were first introduced in semiconductor manufacturing during the early days of integrated circuit (IC) production, with basic clean room protocols focusing on the reduction of dust and particulate contamination. However, as device geometries became smaller and the demand for higher performance and efficiency increased, clean room technology had to evolve rapidly. In the early 2000s, clean rooms were primarily classified using standards such as the Federal Standard 209E, which provided a framework for controlling the number of particles in a cubic foot of air. Over time, these standards were superseded by the more stringent ISO 14644-1 classifications, which are based on the number of particles per cubic meter of air [7]. The evolution of clean room technology is closely tied to Moore's Law, which predicts the doubling of transistors on a chip roughly every two years. As manufacturers strive to meet this exponential increase in transistor density, clean room technology must keep pace by delivering ever-cleaner environments. Today's semiconductor fabs operate with clean rooms that are rated as ISO Class 1 to ISO Class 5, with ISO Class 1 being the most stringent. These clean rooms are designed to limit the presence of even the tiniest particles, measuring fractions of a micron, that could disrupt the fabrication process[8].

Importance of Clean Room Standards

Maintaining clean room standards is essential for ensuring the consistency and reliability of VLSI fabrication processes. International standards such as ISO 14644-1 establish guidelines for controlling the levels of airborne



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particulates, temperature, humidity, and pressure within clean rooms[9]. These standards define the cleanliness levels required for different stages of semiconductor manufacturing, allowing fabs to tailor their environments to the specific needs of each process. For example, the early stages of wafer fabrication, such as silicon ingot slicing and initial processing, may take place in less stringent clean room environments, while critical steps like photolithography and ion implantation require the highest levels of cleanliness to prevent contamination of the wafer [10-13]. The rigorous implementation of clean room protocols ensures that semiconductor manufacturers can achieve high yields—i.e., the percentage of wafers that meet quality standards after fabrication. High yield is a critical factor in the economics of semiconductor manufacturing, as defects caused by contamination can lead to costly waste and lower profit margins. In fact, the ability to maintain clean room conditions is often a determining factor in the competitiveness of semiconductor companies, as even small improvements in yield can have significant financial benefits [10][14].

The sensitivity of semiconductor devices to airborne particles, chemical contaminants, and electrostatic discharge (ESD) makes it essential to maintain clean and controlled environments during fabrication. Contaminants such as dust, organic vapors, and residual moisture can severely affect processes like photolithography, thin-film deposition, and doping. Even a single particle measuring 0.1 μm can cause defects in circuits with feature sizes at the nanoscale[15]. In clean rooms, the concentration of contaminants is carefully controlled through the use of specialized filtration and airflow systems. A well-maintained clean room environment is fundamental to enhancing yield and ensuring process repeatability in VLSI fabrication. In fact, clean room conditions directly influence the success of fabrication steps like etching, lithography, and chemical vapor deposition (CVD), which are highly sensitive to particulate and molecular contamination[16-21].

Clean Room Classifications

Clean rooms are classified based on the level of particle contamination permissible in the environment. Two primary standards are used to classify clean rooms:

ISO 14644-1 Standard: Established by the International Organization for Standardization (ISO), this standard classifies clean rooms based on the concentration of particles per cubic meter of air. Classifications range from ISO Class 1 to ISO Class 9, with Class 1 being the cleanest. For VLSI fabrication, ISO Class 1 and Class 5 clean rooms are the most common. An ISO Class 1 clean room limits particles of size 0.1 μm to less than 10 particles per cubic meter, making it suitable for advanced lithography and processes that require the utmost cleanliness.

Federal Standard 209E: While now mostly replaced by ISO standards, this U.S. standard was widely used in semiconductor manufacturing. It classified clean rooms by the number of particles per cubic foot, with Class 1, Class 10, Class 100, and so on. A Class 10 clean room allows no more than 10 particles (0.5 μm and larger) per cubic foot. This standard is still referenced in older facilities and literature.

Clean rooms are classified according to the maximum permissible concentration of airborne particles, with classifications determined by the number of particles of a specific size allowed per cubic meter of air. Lower class numbers indicate cleaner environments with fewer particles, which is essential in sensitive manufacturing processes like VLSI fabrication. The most widely used clean room classification standards include ISO 14644-1 and the earlier Federal Standard 209E, which defines cleanliness levels based on particle size and concentration.

Some common clean room classifications include:

Class 1: This is the cleanest environment and allows a maximum of 1 particle of size 0.5 micrometers (μm) or larger per cubic foot of air. Class 1 is typically required in highly sensitive fabrication processes, such as advanced photolithography for sub-10nm nodes, where even the smallest particle can disrupt the manufacturing process and affect chip performance.

Class 10: In Class 10 clean rooms, no more than 10 particles of size 0.5 μm or larger are permitted per cubic foot of air. This classification is used in applications where minimal contamination is tolerated, such as in early stages of semiconductor processing or precision optical manufacturing.



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Class 100: Clean rooms classified as Class 100 allow a maximum of 100 particles of size 0.5 μm or larger per cubic foot of air. Class 100 environments are typically used for wafer processing in VLSI fabrication, where the presence of small particles can still cause defects, but the process is not as sensitive as lithography.

Class 1000: Class 1000 environments allow up to 1000 particles of size 0.5 μm or larger per cubic foot of air. This classification is used for less sensitive processes within semiconductor manufacturing, such as certain stages of wafer handling and back-end assembly, where contamination control is necessary, but not as stringent.

These classifications serve as the foundation for maintaining strict environmental control within semiconductor fabs, ensuring high yields and minimizing defects. Advanced VLSI fabrication, particularly for sub-10 nm technologies, often requires clean rooms with the most stringent classifications, such as ISO Class 1 or 10, to prevent even the smallest particles from interfering with the delicate processes involved. Fig.1 depicts the standard key elements of clean room architecture.

Key Components of Clean Room Technology

Air Filtration System

The air filtration system is the cornerstone of contamination control in clean rooms. Airborne particles can come from various sources, including people, equipment, and the materials used in fabrication. Two types of filters are predominantly used in clean rooms:

High-Efficiency Particulate Air (HEPA) Filters: HEPA filters are designed to trap 99.97% of airborne particles that are 0.3 μm or larger. These filters are highly effective in ISO Class 5 clean rooms and above, where processes like wet etching and plasma-enhanced deposition are carried out. HEPA filters ensure that particle levels remain well within acceptable limits, preventing contamination of sensitive processes. Fig 2 represents the standard HEPA filter installation in clean room.

Ultra-Low Penetration Air (ULPA) Filters: ULPA filters offer even greater efficiency, trapping 99.9995% of particles as small as 0.12 μm . These filters are essential for ISO Class 1 and Class 3 clean rooms, where advanced lithographic techniques and extremely fine patterning occur. The use of ULPA filters ensures that the air remains free of sub-micron particles that could lead to defects in the nanometer-scale features of VLSI circuits [1].

Laminar Air Flow

In clean rooms, airflow must be carefully controlled to prevent the accumulation and movement of airborne contaminants. Laminar flow refers to air moving in parallel layers with minimal turbulence. Clean rooms for VLSI fabrication typically utilize vertical laminar airflow systems, in which air flows from the ceiling to the floor in a uniform direction as shown in fig. 3. This design prevents particles from recirculating in the clean room, reducing the risk of contamination during sensitive processes like photolithography or ion implantation. In contrast, turbulent flow clean rooms, where air flows in multiple directions, are not suitable for environments that require ultra-clean conditions. Laminar flow hoods and workstations are often used for specific processes that demand particularly stringent particle control, such as wafer handling and chemical mixing [2].

Temperature and Humidity Control

Temperature and humidity fluctuations can introduce a range of problems in VLSI fabrication. Variations in temperature can cause materials to expand or contract, leading to misalignment of patterns or defects in the thin films. Similarly, uncontrolled humidity levels can lead to condensation, corrosion, or chemical instability in photoresists. In VLSI clean rooms, the temperature is generally maintained between 20°C and 25°C, with deviations kept to within $\pm 0.5^\circ\text{C}$. Humidity control is equally important, especially in photolithography, where excess moisture can degrade photoresists or impact the adhesion of films. Typically, relative humidity (RH) is maintained between 30% and 50% to mitigate these risks. Dehumidifiers and humidifiers are integrated into the clean room's HVAC system to provide real-time control of environmental conditions [3].

Pressure Control

Clean rooms operate at a higher pressure than adjacent areas to prevent contaminants from entering when doors are opened. This positive pressure ensures that air flows outward rather than inward, reducing the risk of



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contamination. Positive pressure is maintained through airlocks and pressure sensors, which regulate the differential pressure between clean rooms and less-controlled areas. Clean rooms are typically divided into zones with different pressure levels, ensuring that more critical zones (e.g., photolithography areas) have the highest pressure to prevent backflow from less clean environments. For VLSI fabrication, this pressure control is crucial in maintaining clean conditions throughout various stages of production [4].

Clean Room Protocols for VLSI Fabrication

Personnel and Garment Protocols

Personnel are among the largest sources of contamination in clean rooms. Skin particles, hair, and clothing fibers can introduce unwanted particles into the controlled environment. To mitigate this, strict protocols are followed for personnel entering a clean room:

Clean Room Suits (Bunny Suits): Operators wear full-body suits made from non-linting materials that prevent the shedding of skin cells and hair. These suits, often referred to as "bunny suits," cover the entire body, including hair and facial features. Booties, gloves, and face masks are worn to prevent contamination from body heat or respiration.

Air Showers: Before entering the clean room, personnel pass through air showers where high-velocity air jets remove any particles clinging to their suits. This ensures that no contaminants are carried into the clean room on their clothing.

Equipment and Material Handling

The equipment used in VLSI fabrication, such as lithography machines, etching chambers, and chemical deposition systems, must be kept impeccably clean. Any equipment brought into the clean room undergoes thorough decontamination processes, which can include vacuum sealing and the use of solvents to remove particulates. Materials such as wafers and chemicals are also pre-cleaned and sealed in sterile packaging to prevent contamination during handling [5].

Routine Monitoring and Cleaning

Clean rooms are continuously monitored for particle levels, temperature, humidity, and pressure. Automated systems provide real-time feedback on environmental conditions, allowing for rapid intervention if contamination levels rise. Regular cleaning schedules are maintained to ensure that the clean room remains within the defined contamination limits. Floors, walls, and equipment are cleaned using specialized solvents and wipes that do not introduce additional particles [6].

Impact of Clean Room Technology on VLSI Fabrication

Yield Improvement

Clean room technology is essential for improving the yield of VLSI fabrication. Even minor contamination can lead to the failure of integrated circuits, reducing the overall yield and increasing production costs. As feature sizes shrink in advanced nodes (e.g., 7 nm and below), the need for cleaner environments becomes more critical. Without adequate clean room controls, manufacturers would face unacceptably high defect rates, making it difficult to produce cost-effective chips at high volumes [7].

Process Consistency

VLSI fabrication processes, such as photolithography, chemical vapor deposition (CVD), and ion implantation, require highly consistent environmental conditions to achieve reproducible results. Clean room technology ensures that temperature, humidity, and particulate levels remain stable throughout production runs, minimizing process variability. This consistency is especially important for advanced lithography techniques like deep ultraviolet (DUV) and extreme ultraviolet (EUV) lithography, where precise patterning is essential [8].

Recent Advancements in Clean Room Technology

Smart Clean Rooms

The integration of smart technologies such as IoT sensors, artificial intelligence (AI), and big data analytics is transforming clean room management. Smart clean rooms feature real-time monitoring systems that can detect





fluctuations in particle levels, temperature, or pressure, allowing for immediate corrective action. AI algorithms can analyze environmental data to predict potential equipment failures or contamination events, helping to reduce downtime and improve overall productivity. For example, predictive maintenance systems can alert operators when a HEPA or ULPA filter needs replacement, reducing the risk of contaminants entering the clean room due to filter degradation. Similarly, AI-based analytics can optimize energy consumption by adjusting airflow and temperature settings based on real-time data [9].

Energy Efficiency

Clean rooms consume significant amounts of energy due to the continuous operation of air filtration systems, HVAC systems, and lighting. Recent advancements in energy-efficient technologies are helping to reduce the carbon footprint of clean rooms without compromising cleanliness. For instance, energy-efficient HEPA and ULPA filters have been developed to reduce airflow resistance, thereby lowering the energy required for air circulation. Additionally, some clean rooms are now equipped with air recycling systems, which filter and reuse a portion of the air, further reducing energy consumption [10].

Modular Clean Rooms

Modular clean rooms offer a flexible and cost-effective solution for semiconductor manufacturers. These clean rooms are constructed from prefabricated modules that can be quickly assembled and customized to meet specific environmental requirements. Modular clean rooms are ideal for research and development facilities or small-scale production, where rapid deployment and scalability are key. Moreover, they provide the flexibility to expand or reconfigure clean room space as manufacturing needs change [11-13].

Challenges and Future Trends

Contamination Control at the Atomic Scale

As semiconductor manufacturers move towards feature sizes below 5 nm, contamination control must address not only particulate contamination but also atomic and molecular-level contamination. Even a single molecule of an unwanted substance can disrupt the performance of nanoscale devices. Future clean room designs will need to incorporate advanced filtration technologies that can remove molecular contaminants from the air. Additionally, improvements in surface cleaning techniques will be required to ensure that wafers and equipment are free from atomic-level contaminants [12].

Integration with Quantum and Nanoelectronics

Emerging fields such as quantum computing and nanoelectronics present new challenges for clean room technology. Quantum devices are even more sensitive to environmental factors than traditional semiconductor devices. For instance, quantum devices may require clean rooms with ultra-low electromagnetic interference (EMI), cryogenic cooling systems, and even more stringent particle control. The development of clean rooms that can support these advanced technologies will be critical to the future of semiconductor fabrication [11][18-20].

Cost Reduction Strategies

While clean room technology is essential for VLSI fabrication, it is also one of the most significant cost drivers. The cost of building and maintaining a clean room can account for a large portion of a semiconductor fab's operating expenses. As a result, there is ongoing research into reducing the cost of clean room operations without sacrificing performance. Hybrid filtration systems that combine mechanical and chemical filtration, for example, offer a promising avenue for reducing the cost of air filtration. Additionally, clean rooms are adopting smart energy management systems that use data analytics to optimize energy consumption based on real-time environmental conditions [23].

CONCLUSION

Clean room technology is a critical enabler of VLSI fabrication, providing the contamination control necessary for the production of advanced semiconductor devices. As transistor sizes shrink and process complexity increases, the need





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for ultra-clean environments becomes even more pronounced. Recent advancements, including smart clean rooms, energy-efficient systems, and modular designs, are helping semiconductor manufacturers maintain the high standards required for modern VLSI fabrication. Looking ahead, clean room technology will continue to evolve to meet the demands of next-generation technologies such as quantum computing and nanoelectronics. However, challenges such as atomic-scale contamination control and cost reduction will need to be addressed to ensure the continued success of semiconductor manufacturing.

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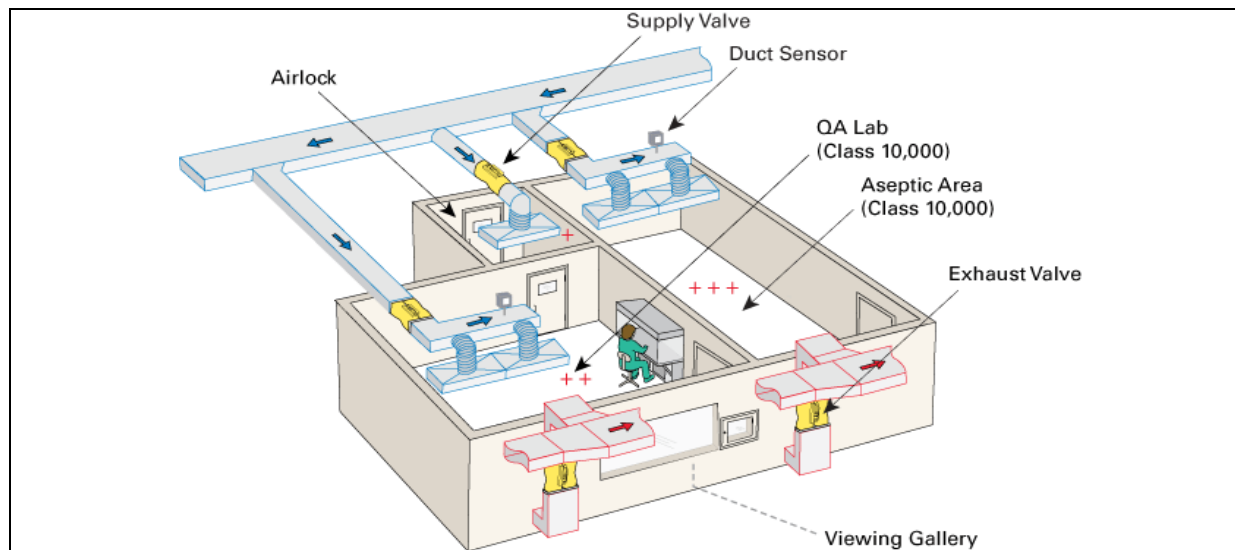


Fig.1 :Standard clean room architecture[4].

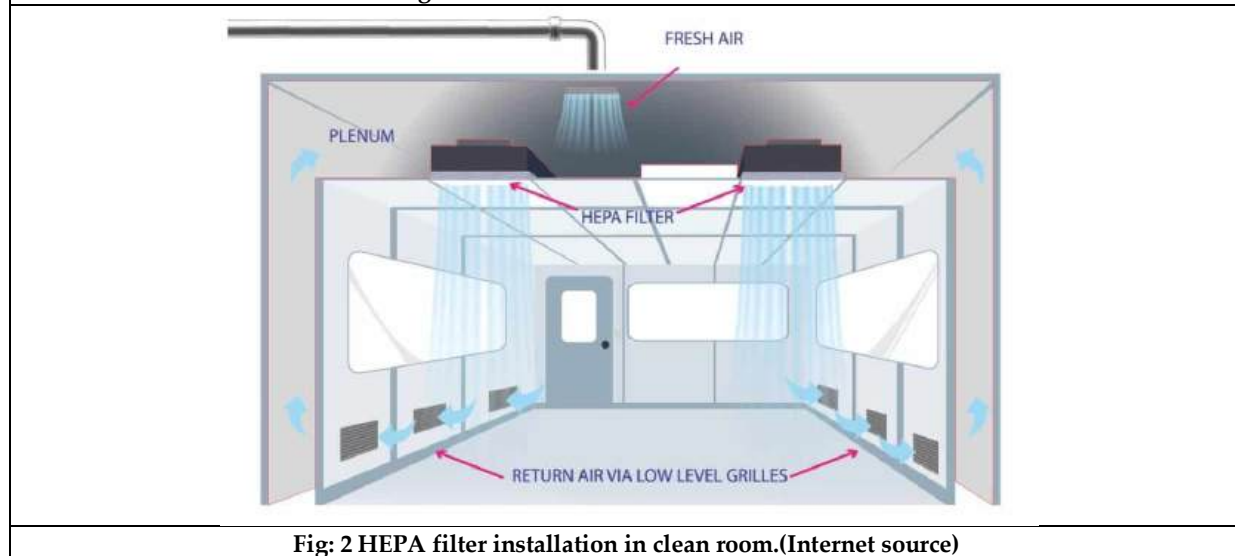
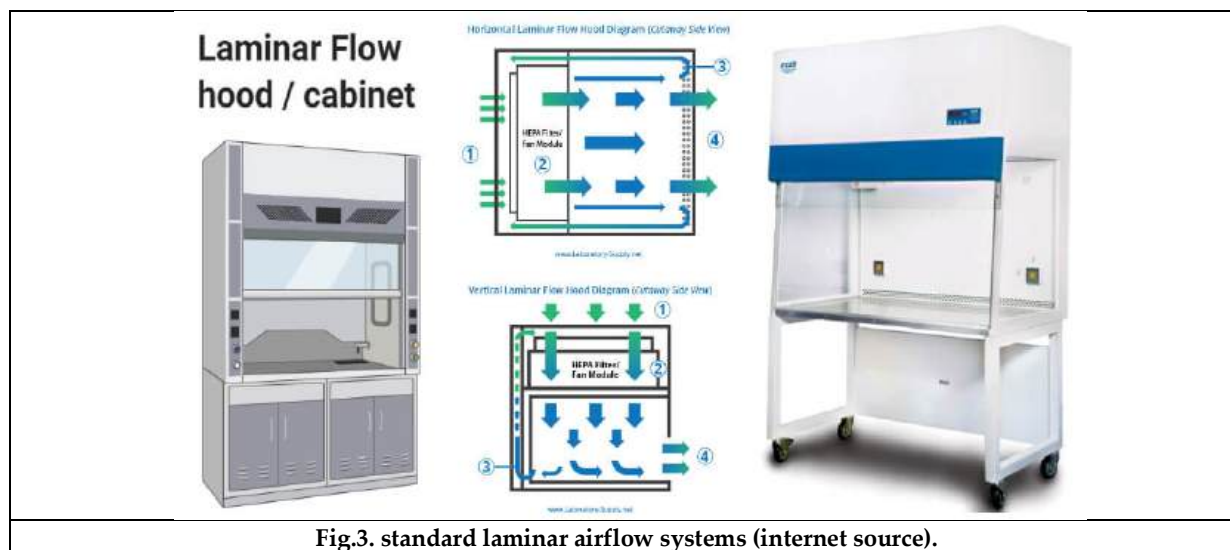


Fig: 2 HEPA filter installation in clean room.(Internet source)







Using IOT Enhanced Urban Planning

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ABSTRACT

In smart city initiatives, the Internet of Things is implemented intelligently. This procedure is now widely used across the world. Various technological hardware and network standards are utilised to keep connected urban infrastructure running smoothly. This smart city initiative reduces CO₂ emissions while increasing autonomy. This approach employs RFID to ensure smart parking. This study may assess the relationship between these protocols. The Internet of Things improves safety and security concerns while increasing high-quality architecture could be architectural excellence is critical for IoT deployment to be sustainable. IoT adoption presents a number of obstacles, including DoS and other security risks.

Keywords: IoT, DoS, RFID, and self-driving cars

INTRODUCTION

These days, cities need to develop and prosper, and the Internet of Things has improved city productivity by requiring clever and creative solutions. Putting the Internet of Things into practice may save management expenses and improve operational effectiveness. Internet boxes and televisions in households are equipped with Internet of Things devices. The real estate industry, smart door locks, smart thermostats, smart alarms, and other devices and programs are all part of a smart city. An Internet of Things-enabled city may be made smarter through a variety of techniques. This study outlines the several shortcomings associated with IoT implementation for smart cities. Understanding the correct implementation and uptake of IoT is crucial.

IOT-Enabled Urban Development

Potential applications, such as the Internet of Things, are effectively applied to improve the efficacy of smart cities. According to Kim et al., the Internet of Things is an emerging technology that is widely employed and implemented. This technology has the capability of creating smart cities without the need for human interaction. The





number of internet-connected gadgets has grown faster than the number of people. Figure 1 depicts the rise of smart technology as determined by Market Research Firm. Fig1 depicts a large number of commercial buildings and smart residences. To improve power efficiency, it is crucial to maintain water management and smart power. Advanced sensor technology is utilized to capture crucial environmental data, whereas addressing sensors are used to monitor the Internet of Things. IoT technology is used to gather and analyse data. The Internet of Things facilitates decision-making and information transmission, which has a direct influence on smart cities (Park et al. 2023). The adoption of the Internet of Things requires proper communication standards. Several international organisations are active in communication standardisation. The International Telecommunication Union, the Institute of Electrical and Electronics Engineers, Global Standard I, and the Internet Engineering Task Force work together to improve smart cities using the Internet of Things. This set of software and hardware solutions aims to improve urban intelligence. A smart city's linked networks, software components, and data storage systems all help to keep it running smoothly. The Internet of Things promotes technical advancement, integration, and intelligent settings. A smart city is connected to physical infrastructure. To increase a city's efficiency and intelligence, it is required to conduct business. Physical, information, and communication technologies, as well as social infrastructure, are all examples of infrastructure. Large-scale IoT deployment can boost city smartness. Protocols for communicating between machines and with humans are properly implemented. The Internet of Things is implemented using wireless sensor networks. According to Hammi et al. (2022), this approach is used to generate information to improve the Common Operating Picture (COP) of the city's diverse platform and apps.

IOT as A Technology for Smart City

The IoT idea is effectively being leveraged to allow smart city rollout throughout the world. The Internet of Things technology allows objects to be managed and monitored remotely. Multiple sources of traffic data in real time can give insights into the examination of different technologies. Infrastructure development might have an impact on IoT product quality. This technique can help to keep transit and municipal services affordable. The Internet of Things' potential maintains smart city architects and features. The Internet of Things and the delivery process are safeguarded by the effectiveness of the system.

Needs and Practical Examples for IOT in Smart Cities

The inclusion of IoT platforms and smart city solutions meets the Internet of Things' requirements. Implementing the Internet of Things allows you to manage many systems, networked devices, and people. The IoT platform reduces cost-related risks. The Internet of Things connects several heterogeneous systems across the city. In this case, the IoT techniques' installation time is shortened, which is an important aspect of a smart city endeavour. IoT technology and increasing security concerns continue to provide new prospects for the city. The IoT enables the connecting of devices and data. The Internet of Things procedure maintains a variety of capabilities, pressure, temperature, light, and humidity, among others. The IoT controls several industries. Smart routes and connectivity via 4G and 5G technologies, as well as wifi, enable people to communicate, offer information about accidents, and traffic. A linked automobile significantly improves driving conditions. This method is carried out by gathering and sharing traffic conditions and real-time traffic data. Smart cities employ high-performance telecommunication technology to maintain numerous links within and outside of the city and deliver various services to its people (Simmhan et al. 2023).

Smart City IOT Application

Different Internet of Things allocations must be kept in order to analyse the IoT paradigm. Information and knowledge about the application of information and communication technologies are being gathered through a variety of research and planning processes. It is essential to understand the workings of information and communication technologies in order to bring a smart city notion to life.

The Structure's Health

Continuous monitoring and knowledge about the building's state are crucial factors for preserving the historical structure. Because of the involvement of many external agents in the construction process, it is critical to justify all



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impacted regions, which might boost building potential. The city contains a number of structural structures of varying eras and sizes. The structures of bridges, buildings, and dams are all really ancient. WSNs are included into concrete structures and are capable of evaluating a building's condition (Park et al., 2023). To learn more about the condition of the building, a radio signal with the appropriate amplitude is utilised.

Waste Management

Waste management is viewed as a growing concern in cities. Waste management is influenced by both socioeconomic and environmental issues. The waste management process, like the environment, helps to keep things sustainable. The adoption of IoT infrastructure improves data collecting capability, which is seen as a significant advantage of the Internet of Things. Along with them, IoT technology effectively manages a variety of smart city concerns. IoT technology can assist trash trucks collect all rubbish. The LPWAN technology is utilised to communicate with multiple computer servers. The waste collection operation is carried out utilising garbage trucks.

Concise Parking

A smart parking procedure is provided by installing wireless sensors in parking spots. There's a new sensor bus parking system that might alert drivers when they get out of a parked car. In Madrid, Spain, three essential elements are used to maintain the functionality of this smart parking system. Urban bus networks that are network-enabled and have wifi connection are seen to be an essential part of smart cities. Bus passengers are trying to access all of the smart parking facilities by using UBN navigation. Implementing a crowd information server is essential for operating buses differently. This entire procedure uses Internet of Things technology. IoT technology maintains parking bay occupancy. High-performing servers keep track of parking vacancies. Several visualisation platforms, including cellphones, are used. To provide a wide range of information. Radio Frequency Identity Technology, which is fuelled by Internet of Things technology, is required to sustain the vehicle identity process. An advice board is part of a smart parking system, along with human-machine interaction. RFID, barriers, and scanners are just a few of the high-performance technology used to maintain parking lot check-out and check-in.

Consumer Grid

According to Bates and Friday (2022), in addition to IoT technology maintaining the transmission, consumption, and distribution processes, smart grids incorporate various new technologies such as autonomous and intelligent controllers. These technologies facilitate two-way communication between power utilities and consumers, enhancing data management processes within the grid. This integration forms a distributed and automated advanced energy delivery network. Successful deployment of smart grid sensing infrastructure ensures the transmission of information critical to managing power networks efficiently.

IoT Challenges For Creating Smart Cities

The Internet of Things incorporates several technologies, and as a result, security challenges have expanded significantly. The adoption of the Internet of Things has led to an increase of new concerns. Networking, transportation, scalability, privacy, authentication, and heterogeneity are all emerging as major difficulties for smart cities. Several hurdles to Below is a list of IoT applications in smart cities.

Network and Transit Issues

Santos et al. (2022) highlighted that the Internet of Things (IoT) encompasses a vast array of accessible devices, allowing authorized users to access generated content. IPv4 remains the most widely used protocol for achieving desired goals and complying with relevant policies. However, IPv6 is considered the superior successor to IPv4. RFID (Radio Frequency Identification) is utilized for identification purposes and is tagged using the IPv6 protocol, enabling various advanced techniques to be studied.

Matter of Security

This security issue is viewed as a serious IoT challenge, with direct implications for sustainability, corporate competitiveness, and administration. The Federal Trade Commission states that the rise of IoT technology is





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accompanied by a number of security concerns. However, IoT is tested several security issues, comprising sufficient memory, CPU power, industry-standard security solution processes, and other up-to-date security measures. Man-in-the-middle attacks and inadequate wireless connectivity are seen to be the main IoT issues, which hinders its uptake.

Denial of Service

Because of the widespread deployment of internet devices in cities, real-world attack avenues for evil individuals are available. In large cities, thousands to ten thousand devices are in use at the same time. To conduct various duties and maintain devices, an IoT bot net was successfully deployed. IoT technology maintains the DNS service. In this case, a number of interconnected devices are essential to the attack, but IoT was unable to identify them before it happened. Cyberattacks using Internet of Things technology have increased. shows the cloud computing infrastructure and the IoT cross-thematic data management process that support a smart city.

CONCLUSION

The incorporation of the Internet of Things can improve the smartness of cities. Various countries, such as the United States, China, and the UAE, can adopt smart city programs. Based on this research, it is stated that IoT may give the best solution to create a smart city, which includes smart parking, smart health, high-quality waste management, building health, and self-driving. These are considered a key component of a smart city. IoT implementation presents a number of obstacles, including security concerns, denial of service attacks, and networking and parking issues.

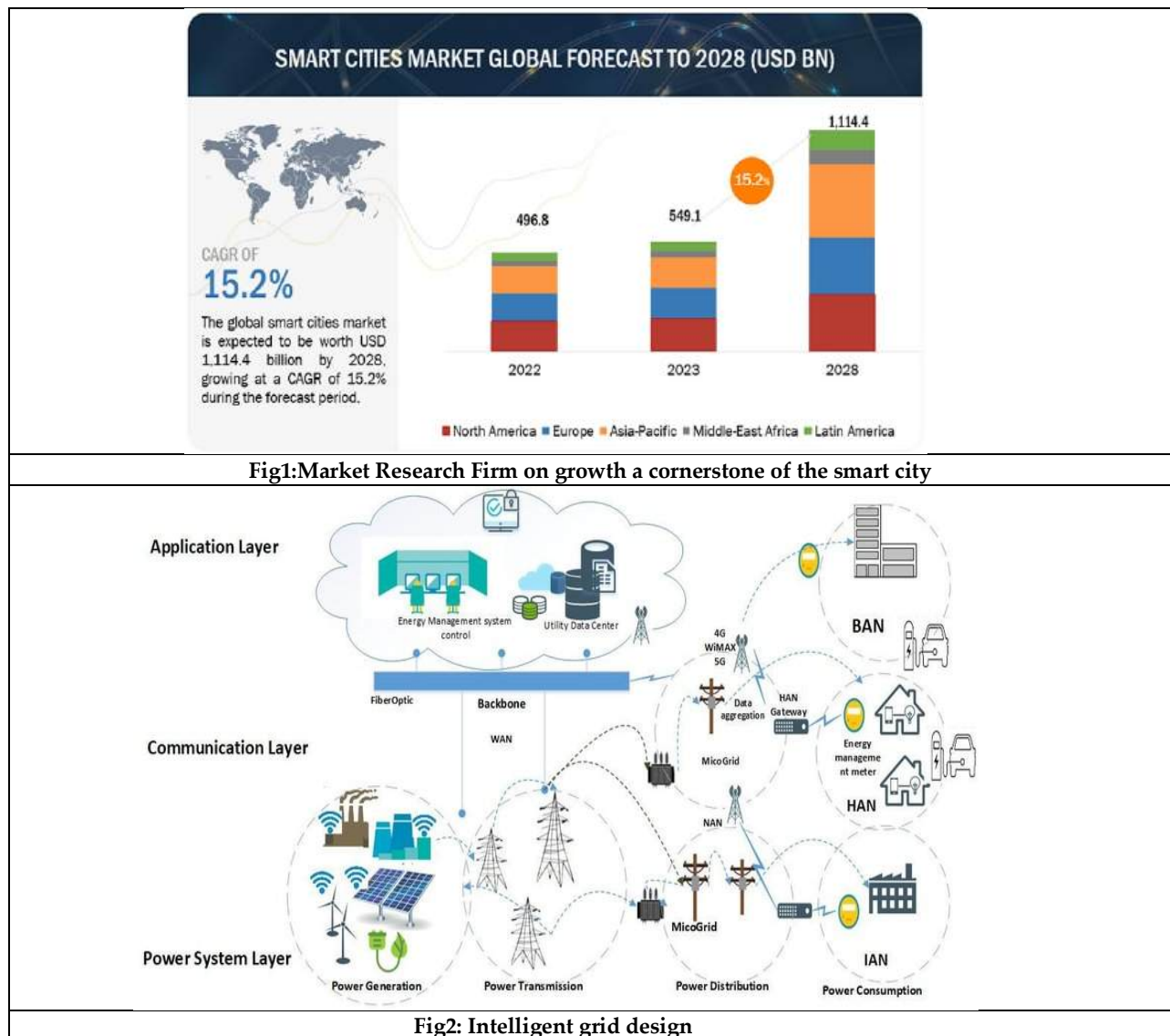
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Stock Market Swing Trading Strategies

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ABSTRACT

This paper explores a swing trading strategy on Motherson Sumi Systems Ltd. stock, utilizing Relative Strength Index divergences combined with Bollinger Bands set at a multiplier of 3. The study investigates how these technical indicators, when applied together, can provide reliable signals for entry and exit in swing trading

Keywords: Swing trading, technical analysis, Indian stock market, Risk management.

INTRODUCTION

Swing trading[1] is one the best trading with low risk and low gain in volatile markets has gained significant traction among retail traders whereas day traders need to take risk. The objective of this paper is to examine the feasibility and profitability of swing trading strategies in the Indian context, where market volatility[2], liquidity, and regulations present unique challenges. The study also explores how specific technical indicators can assist traders in making informed decisions, identifying trade setups, and managing risk effectively.

METHODOLOGY

A key tool in swing trading is the use of Support and Resistance[3].

Here traders need to identify potential reversal zones where the stock price is likely to change direction. **:Bounce Strategy:** When a stock's price approaches support or resistance, swing traders look for the price to "bounce" off





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these levels. For example, if the price falls to a support level and then starts to rise again, this may indicate a buying opportunity

Breakout Strategy: If share the price crosses support or resistance with strong momentum, it could signal the start of a new trend. In this case, traders take entry positions accordingly.

Buy Near Support: When the price approaches a strong support level and shows signs of reversal (such as bullish candlestick patterns or increased volume), swing traders may enter long positions.

Sell Near Resistance

Take Profits at Opposite Levels: Swing traders often aim to exit trades when the price approaches the opposite level—selling at resistance or buying back at support.

Also, for confirmation better to use some technical indicators like RSI, moving averages crossover, candlestick patterns like hammer, engulfing etc.

Successful swing trading relies heavily on effective risk management like stop loss, position sizing, risk reward ratio etc.

Real time example of a Swing Trade Using RSI divergence [5], Bollinger band [4] multiplier 3, support and resistance of Mothersonstock

The above figure shows that Mothersonstock is not at support nor at resistance The above figure shows that Motherson stock is at resistance price on 18 July also RSI divergence bear signal is generated thus one opportunity to sell mother son 1 lot future @206 on 18 July The above figure shows that Motherson stock is at support price on 5 Aug also it crosses Bollinger band lower line indicating buy opportunity Buy mother son future 2 lots @170 on 5 Aug 2 lots one to close previous month sell order and one for holding for next cycle The above figure shows that Motherson stock is at resistance price on 18 September also it crosses Bollinger band upper line indicating sell opportunity also RSI is 18 was above 71 further strengthening sell decision Sell mother son future 1 lot @208 on 18 September Some real time examples for intraday swing trading In daily chart using trading view: See resistance for Motherson stock is around 205 and support is around 180 So, one can buy Motherson @ 180 when it reaches 205 it could be sold Support price for Motherson stock is 180 and resistance 205 note it support and resistance can change according news base so before taking any decision maintain strict stop loss In 5 min chart IDEA: See support is at Rs.10:50 So, one can buy IDEA @ 10:50 note it support and resistance can change according news base so before taking any decision maintain strict stop loss In intraday chart using trading view: See resistance for nifty 25900 and support is around 25550 in 5 min chart So, one can buy nifty future @ 25550 and when it reaches 25900 it could be sold Support price for nifty on 23-9-24 is 25550 and Resistance 25900 note it support and resistance can change according news base so before taking any decision maintain strict stop loss

RESULTS AND DISCUSSION

Summary of Motherson Stock Support, Resistance, and Trading Decisions (April - September 2024)

This summary outlines the key observations for Motherson stock over six months in 2024, with particular focus on support and resistance levels, Bollinger Bands (multiplier 3), and RSI divergence signals.

1. April 2024

Observation: The stock did not show signs of being at either support or resistance.

Action: No trading opportunities were identified, as the stock remained within normal trading ranges without touching any key technical levels.

2. May 2024

Observation: Similar to April, Motherson stock was neither at support nor resistance.

Action: No buying or selling actions were triggered, as the price did not approach critical zones of interest.

3. June 2024

Observation: Again, the stock was not near any support or resistance levels during this month.

Action: No trades were initiated, as there were no signals indicating a significant price movement.

4. July 2024



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Observation: On July 18, 2024, the stock hit resistance at ₹206, and a bearish RSI divergence signal was generated. This combination of indicators suggested a selling opportunity.

Action: A sell order for 1 lot of Motherson futures was executed at ₹206 on July 18, 2024. This marked a clear opportunity to capitalize on the stock reaching resistance.

5. August 2024

Observation: On August 5, 2024, the stock reached support at ₹170, while also crossing above the lower Bollinger Band (multiplier 3). This indicated a potential buy opportunity.

Action: A buy order for 2 lots of Motherson futures was placed at ₹170. One lot was to close the previous month's sell position and the other lot was to hold for the next cycle.

6. September 2024

Observation: On September 18, 2024, Motherson stock hit resistance at ₹208, crossing above the upper Bollinger Band. The RSI was also above 71, strengthening the decision to sell.

Action: A sell order for 1 lot of Motherson futures was executed at ₹208 on September 18, 2024. This was a well-timed exit based on overbought conditions and technical signals indicating a price reversal.

Summary Report on Intraday Swing Trading

This report provides real-time examples of intraday swing trading strategies applied to Motherson, IDEA, and Nifty using support and resistance levels. These trades aim to capture price swings within short time frames, often taking advantage of price movements between known support and resistance levels. All examples emphasize the importance of setting strict stop-losses to manage risk due to potential market volatility or news events.

1. Stock: Motherson (Daily Chart)

Resistance: ₹205

Support: ₹180

Strategy:

Buy at ₹180 (when the stock reaches its support level).

Sell at ₹205 (when the stock hits resistance).

Motherson stock shows a clear price range between ₹180 (support) and ₹205 (resistance). Traders can enter a buy position near support levels and close their positions when the stock reaches resistance. However, it's important to note that support and resistance levels can shift due to news or market sentiment. Therefore, maintaining a strict stop-loss above ₹180 is critical to protect against potential losses.

2. Stock: IDEA (5-Min Chart Dated 24-09-2024)

Support: ₹10.50

Strategy:

Buy at ₹10.50 (at the identified support level).

In this 5-minute chart, IDEA's stock shows a support level around ₹10.50. Traders could initiate a buy position when the stock dips to this support level, expecting a bounce. The stop-loss should be set just above ₹10.50 to limit losses if the price breaks above the support.

As with any intraday strategy, it's important to monitor news events that could alter the technical setup and cause price levels to shift unexpectedly.

3. Nifty (Intraday 5-Min Chart)

Resistance: ₹25,900

Support: ₹25,550 (dated 23-09-2024)

Strategy:

Buy Nifty futures at ₹25,550 (support level).

Sell at ₹25,900 (resistance level).

On an intraday 5-minute chart, Nifty futures have clear support at ₹25,550 and resistance at ₹25,900. A trader could enter a buy position at the support level and aim to sell when the price reaches resistance at ₹25,900. As with the





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other examples, it's crucial to set a stop-loss above ₹25,550 to mitigate potential downside risk if the support level breaks due to market factors.

Key Takeaways for Intraday Swing Trading

Support and Resistance: Identifying key levels of support and resistance is fundamental for successful swing trading. Buying at support and selling at resistance allows traders to capitalize on price fluctuations.

Stop-Loss: Always use a strict stop-loss to protect against unexpected price movements, especially when trading based on technical patterns that may shift due to market news or external factors.

Market Sensitivity: Support and resistance levels can change based on news events, so staying updated on market developments is essential to adapt the trading strategy accordingly.

These examples demonstrate how support and resistance levels can guide intraday swing trading decisions, providing opportunities to profit from short-term price movements while managing risk through stop-loss orders.

Finally Result Summary on Motherson Future Trading (Lot Size: 7100)

date	entry/exit price	buy	sell	investment	profit = diff(lot size)	profit released in rupees
18-07-2024	Rs. 206		1 lot	Rs. 3 lakhs		
05-08-2024	Rs. 170	2 lots		RS. 3 lakhs	(206-170)x7100	255600
18-09-2024	RS. 208		1 lot		(208-170)x7100	269800
						525400

The following outlines the trading actions on Motherson futures, including the lot size, trade execution prices, and final profit:

Trade Details:

July 2024: Sold 1 lot of Motherson futures (7100 shares per lot) at ₹206.

Proceeds: ₹206 × 7100 = ₹1,462,600.

August 2024: Bought 2 lots at ₹170.

Cost: ₹170 × 7100 × 2 = ₹2,414,000.

September 2024: Sold 1 lot at ₹208.

Proceeds: ₹208 × 7100 = ₹1,476,800.

Investment Needed:

The total capital required for these trades was ₹2,600,00, which covered the margin for trading these futures contracts.

Final Profit Calculation:

Sell in July: 1 lot @ ₹206)

Buy in August: 2 lots @ ₹170)

Sell in September: 1 lot @ ₹208)

Profit from 1 lot (July - August):

Sold at ₹206, bought back at ₹170.

Profit: (206 - 170) × 7100 = ₹255,600.

Profit from 1 lot (August - September):

Bought at ₹170, sold at ₹208.

Profit: (208 - 170) × 7100 = ₹269800.

Total Profit: ₹255,600 + ₹269,800 = ₹525,400.

Final Summary:

Total Investment: ₹2,600,00.





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Final Profit: ₹525,400.

The trading strategy involving Motherson futures resulted in a 202% return on the capital investment. The strategy was profitable due to correctly timed entries and exits, leveraging both upward and downward price movements in the stock.

CONCLUSION

The combination of Bollinger Bands (multiplier 3), support and resistance levels, and RSI divergence provided clear trading opportunities in July, August, and September 2024. These trades leveraged both entry and exit points effectively and this strategy successfully captured swings in Motherson stock, capitalizing on both upward and downward movements.

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Fig 1. Apr 2024 Motherson from
<https://www.tradingview.com/chart/>



Fig 2. May 2024 Motherson
<https://www.tradingview.com/chart/>



Fig 3. Jun 2024 Motherson
<https://www.tradingview.com/chart/>



Fig 4. July 2024 Motherson
<https://www.tradingview.com/chart/>





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Fig 5. August 2024 <https://www.tradingview.com/chart/>Fig 6. September 2024 <https://www.tradingview.com/chart/>

Fig 7. Motherson daily chart



Fig 8. IDEA 5 min chart dated 24-9-24



Fig 9. NIFTY Intraday 5 min chart





Stock Market Nifty Trading Strategies

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ABSTRACT

This paper explores the development of Nifty trading strategies using by integrating Relative Strength Index Divergence and Option chain data. By leveraging real-time option chain data—such as open interest, volume, and put-call ratios—alongside Relative Strength Index divergence, we aim to identify key inflection points and market reversals during intraday sessions. The research explores how these tools can be effectively combined to provide timely entry and exit signals, offering traders a robust framework for capturing short-term price movements. The empirical analysis is conducted using a dataset of Nifty option chains, and Relative Strength Index signals are calibrated to detect divergence across different timeframes.

Keywords: Option chain, RSI divergence, Price action, Trending OI

INTRODUCTION

The Nifty 50 index, one of India's most widely tracked stock market indices, serves as a benchmark for the broader market performance in the National Stock Exchange (NSE). Given its liquidity and volatility, Nifty has become a popular trading instrument for both retail and institutional traders. To effectively navigate the complexities of Nifty trading, traders often rely on a combination of quantitative and technical analysis tools that offer insights into market trends, sentiment, and momentum. This paper focuses on the use of Option Chain analysis[2], Relative Strength Index RSI divergence[3]s as a comprehensive strategy for trading Nifty. Each of these tools provides unique insights that, when used together, can help traders make informed decisions in both trending and volatile markets. Option





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Chain analysis[1] is an essential tool for options traders as it offers real-time data on open interest, strike prices, and implied volatility. The interpretation of open interest at different strike prices provides clues about market sentiment and potential price movements, making it a valuable component of any Nifty trading strategy. RSI, a momentum oscillator[4], helps traders evaluate whether Nifty is in overbought or oversold territory. It signals potential trend reversals by indicating shifts in buying or selling pressure. When used in conjunction with Option Chain data, RSI[5] helps refine entry and exit points, providing traders with more accurate signals to act on. This study aims to explore how the combination of these Option chain and RSI divergence s can be employed to develop effective trading strategies for the Nifty index. By applying these strategies to daily live data and analyse the performance of this multi-faceted approach[6] in different market conditions. The goal is to demonstrate how these tools, when used in conjunction, can improve trade timing, enhance profitability, and minimize risk, offering a structured approach for traders to navigate the dynamic nature of the Nifty index.

METHODOLOGY

Follow the principles of 7 horses' theorem: trend (long, medium, short), momentum (long, medium, short), price action, sentiment (global, local), fundamental - results, news, divergence (option chain, RSI, VWAP), big bull moto (most important) we can able to trade effectively the nifty option by maintaining strict stop loss accordingly Observe the individual charts of nifty 50 stocks which good weightage like reliance, HDFC bank, ICICI Bank, INFY, ITC, TCS, LT, BHARTIARTL , ASIANPAINT, MARUTI, TITAN , TATASTEEL, NTPC, ADANIENET etc. and then see which is moving nifty and which is dragging the nifty then observe Option chain of nifty accordingly

Fig 1. The above nifty stocks charts(1min) taken from <https://www.tradingview.com/> dated 24-9-24

Above reliance pull the nifty upward in morning 20 min but later dragged it down but in after noon it pulled up again

Fig 5. Above AIRTEL bank pulled nifty upward in early morning later downward and then upward again

Note: Not only we need to upward pulling or downward but also, we need to evaluate with how much percentage moving up according to their weightage

Real time Case study on Nifty

Nifty data collected around 9:50 a.m. dated 24-9-24 from <https://web.sensibull.com/home> below table show that @ 25950 228% indicates nifty had a support is 25950

Fig 6. Nifty data collected around 9:50 a.m. dated 24-9-24 from <https://tradingtick.com/options/trending-oi-strike>

Above graph shows 25900 OI is high indicating that nifty will fall above 25900

Fig 7. Nifty data collected around 9:50 a.m. dated 24-9-24 from <https://www.tradingview.com>

The above chart indicating that nifty is consolidating till 950

Tab 2.Nifty data collected around 9:50 a.m. dated 24-9-24 from <https://www.nseindia.com/option-chain>

Call OI 317629 @26000 and PUT OI 258112 @ 25900 indicating that nifty support at 25900 and resistance at 26000

Tab 3. Nifty data collected around 11:30 a.m. dated 24-9-24 from <https://www.nseindia.com/option-chain>

Below table @26000CE OI is 364887>317629(9:50) indicating that nifty resistance is strengthened

Also @25900PE OI is 313458>258112(9:50) indicating that nifty support is also strengthened

Tab 4. Nifty data collected around 11:30 a.m. dated 24-9-24 from <https://web.sensibull.com/home>

Above table show that @ 25950PE 255%>2285(9:50) indicates nifty had a support is 25950





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Fig 8. Nifty data collected around 11:30 a.m. dated 24-9-24

Above graph shows 25900CE is gone out and 26000PE entered indicating that nifty may cross 26000 towards upward, also 26950 PE moves upward indicating that market may move upward above 25950

Fig 10. Nifty data collected around 13:30 p.m. dated 24-9-24 from <https://www.tradingview.com>

As predicted earlier from (Above graph shows 25900CE is gone out and 26000PE entered indicating that nifty may cross 26000 towards upward, also 26950 PE moves upward indicating that market may move upward above 25950 from trading tick) nifty moved above 25950

Tab 5. Nifty data collected around 13:30 p.m. dated 24-9-24 from <https://www.nseindia.com/option-chain>

Below table @26000CE OI is 395948>364887(11:30)>317629(9:50) indicating that nifty resistance is strengthened Also @25900PE OI is 306413<31345811(11:30)>258112(9:50) indicating that nifty support is also little bit weakened

Tab 7. Nifty data collected around 15:10 p.m. dated 24-9-24 from <https://www.nseindia.com/option-chain>

Below table @26000CE OI is 391732<395948(13:30)>364887(11:30)>317629(9:50) indicating that nifty resistance is little bit weakened strengthened Also @25900PE OI is 297524<306413(13:30) <31345811(11:30)>258112(9:50) indicating that nifty support is also little bit weakened

RESULTS AND DISCUSSION

NIFTY Stock Movement Analysis with Weightage Impact

Fig 1: Reliance Industries

- Movement: Reliance pulled NIFTY up in the first 20 minutes of trading but later dragged it down before pulling it up again in the afternoon.
- Weightage Impact: Reliance has one of the highest weightages in the NIFTY index (approx. 10-11%). The initial upward move would have contributed significantly to the NIFTY's rise. However, the downward movement that followed would have exerted a strong negative pressure on the index. The afternoon recovery likely contributed positively to NIFTY's upward trend.

Fig 2: Infosys

- Movement: Infosys remained flat until 2 p.m. but pushed NIFTY upward after that.
- Weightage Impact: Infosys holds a substantial weightage (about 6-7%). The flat movement earlier in the day had little impact on the NIFTY. However, post-2 p.m., the stock's upward movement would have made a notable contribution to the index's rise, albeit less impactful than Reliance.

Fig 3: HDFC Bank

- Movement: HDFC Bank pushed NIFTY upward in the early morning, pulled it downward later, and then moved upward again.
- Weightage Impact: HDFC Bank has a weightage of around 8-9% in NIFTY. The initial upward push had a significant positive influence, but the subsequent downward pull likely balanced out the effect, before contributing positively again in the later part of the day.

Fig 4: ITC

- Movement: ITC exhibited volatility throughout the day, alternating between upward and downward movements.
- Weightage Impact: ITC's weightage is around 4-5%, which is lower compared to Reliance and HDFC Bank. Its frequent fluctuations contributed to minor movements in NIFTY but had less of a significant impact due to its comparatively smaller weightage. The overall effect on the index would have been neutralizing, with alternating upward and downward pressures.

Fig 5: Bharti Airtel

- Movement: Airtel followed a similar pattern to HDFC Bank, pulling NIFTY upward in the early morning, down later, and up again afterward.





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○ Weightage Impact: Bharti Airtel's weightage in NIFTY is around 2-3%, which means its influence on the index is relatively moderate. Despite the stock following the same cyclic pattern, its overall impact on NIFTY's movement would have been more muted compared to Reliance, Infosys, or HDFC Bank.

Summary of Weightage-Based Impact:

- High-Weightage Stocks (Reliance, Infosys, HDFC Bank) had the most pronounced influence on NIFTY's movement due to their substantial weightage. Their movements significantly shaped the index's direction, particularly during times when they shifted trends.
- Moderate-Weightage Stocks (ITC, Airtel) contributed to short-term fluctuations but had a relatively smaller overall effect on the index's performance throughout the day.

NIFTY's overall movement was largely driven by the direction of high-weightage stocks like Reliance, Infosys, and HDFC Bank. The intraday volatility was heightened by ITC, while smaller weightage stocks like Airtel played a moderate role.

NIFTY Data Analysis Summary

The data collected across different times during the day provides insights into NIFTY's support and resistance levels, as well as market movements. Here's a detailed summary:

Data Collected Around 9:50 a.m.

- Tab 1: The NIFTY data showed that at 25950, the support was strong with an Open Interest (OI) increase of 228%, indicating a solid base at this level.
- Fig 6: NIFTY's OI at 25900 was significantly high, suggesting that the index might fall above this level, as high OI at a strike price indicates strong resistance.
- Fig 7: The chart indicated that NIFTY was consolidating up until 9:50 a.m., showing minimal directional movement.
- Tab 2: The Call OI at 26000 was 317629, and the Put OI at 25900 was 258112, suggesting that NIFTY had support at 25900 and resistance at 26000.

Data Collected Around 11:30 a.m.

- Tab 3: The OI at 26000CE had increased to 364887 from 317629 (9:50), strengthening the resistance at 26000. Similarly, the Put OI at 25900PE increased to 313458 from 258112 (9:50), indicating a stronger support level at 25900.
- Tab 4: At 25950PE, the OI increased to 255% from 228% (9:50), reinforcing the support level at 25950.
- Fig 8: The graph showed that 25900CE dropped out, and 26000PE entered, signalling that NIFTY was likely to cross 26000 in an upward direction. Additionally, 25950PE moved upward, indicating that the market might move above 25950.
- Fig 9: The 5-minute NIFTY chart showed consolidation up until 11:30 a.m., but with signs of potential upward movement.

Data Collected Around 1:30 p.m.

- Tab 5: At 26000CE, the OI increased further to 395948 (from 364887 (11:30) and 317629 (9:50)), indicating that the resistance at 26000 was further strengthened. Meanwhile, the OI at 25900PE decreased slightly to 306413 (down from 313458 (11:30)), indicating a minor weakening of support at 25900.
- Fig 10: As predicted earlier, NIFTY crossed 25950, and the market moved upward, as indicated by the earlier analysis.
- Fig 11: This confirmed the upward movement past 25950, showing the market's direction aligning with the earlier prediction.

Data Collected Around 3:10 p.m.

- Tab 7: The OI at 26000CE dropped to 391732 (from 395948 (13:30) but still above 364887 (11:30) and 317629 (9:50)), indicating that resistance at 26000 was slightly weakened. The OI at 25900PE also decreased to 297524 (from 306413 (13:30) and 313458 (11:30)), showing that support at 25900 was weakening over time.
- Fig 12 and Fig 13: These figures reinforced the trends identified earlier, with the market showing signs of approaching the 26000 level but facing some resistance toward the end of the day.





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Closing Data (Tab 9, 15:10 p.m.)

- The closing values showed that NIFTY remained close to 26000, with resistance and support levels fluctuating throughout the day but ultimately weakening slightly as the day progressed.
- Early Morning (9:50 a.m.): NIFTY was supported at 25900 and 25950, with resistance at 26000. The market was consolidating with indications of a potential breakout.
- Mid-Morning to Early Afternoon (11:30 a.m. to 1:30 p.m.): Support and resistance levels strengthened, particularly at 25900 and 26000, and NIFTY showed upward momentum, eventually crossing 25950 as predicted.
- Late Afternoon (3:10 p.m.): Resistance at 26000 weakened slightly, while support at 25900 also showed signs of weakening, indicating potential consolidation or retracement near the end of the trading session.

This intraday analysis highlights how NIFTY's support and resistance levels evolved throughout the day, with the market responding to key price points like 25900, 25950, and 26000.

CONCLUSION

This study highlights the effectiveness of combining Option Chain analysis and Relative Strength Index (RSI) divergence to create successful trading strategies for the Nifty index. Option Chain analysis plays a crucial role in understanding market participants' positions and expectations, offering insights into open interest, put-call ratios, and implied volatility. RSI divergence as a momentum indicator, aids in spotting overbought and oversold conditions, helping traders time their entries and exits more effectively. In conclusion, the combination of Option Chain analysis and RSI offers a powerful, data-driven approach to Nifty trading.

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Tab 1. Nifty data collected around 9:50 a.m. dated 24-9-24 from <https://web.sensibull.com/home>

CALLS						PUTS			
OI Chg%	OI-lakh	Call OI	LTP	Strike ↓	IV	LTP	Put OI	OI-lakh	OI Chg%
-3.1%	3.9		345.80	25650	16.0	26.95		14.5	4.9%
1.3%	33.8		302.10	25700	15.4	32.95		69.2	14%
0.2%	6.5		259.80	25750	15.1	41.70		21.3	23%
0.3%	47.5		220.75	25800	14.8	52.55		68.3	20%
9%	19.3		185.35	25850	14.6	66.95		27.9	21%
16%	51.8		152.65	25900	14.4	84.55		74.0	85%
53%	29.4		123.15	25950	14.2	104.70		27.7	228%
20%	80.8		97.50	26000	13.8	129.30		45.5	49%
29%	18.6		74.85	26050	13.6	157.05		4.4	56%
20%	37.1		56.65	26100	13.5	188.65		7.0	146%
32%	15.6		42.30	26150	13.5	223.55		1.6	158%
17%	57.2		30.60	26200	13.4	262.55		3.7	108%
0.4%	14.1		22.60	26250	13.5	262.05		0.4	418%





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**Tab 2.Nifty data collected around 9:50 a.m. dated 24-9-24 from <https://www.nseindia.com/option-chain>
Call OI 317629 @26000 and PUT OI 258112 @ 25900 indicating that nifty support at 25900 and resistance at 26000**

	OI	CHNG IN OI	VOLUME	IV	LTP	CHNG	BID QTY	BID	ASK	ASK QTY	STRIKE	BID QTY	BID	ASK	ASK QTY	CHNG	LTP	IV	VOLUME	CHNG IN OI	OI
	9,238	-38	226	-	604.35	23.15	200	602.30	604.30	50	25,350.00	12,900	11.10	11.20	9,450	-6.75	11.20	20.96	62,818	617	54,810
	79,833	-271	1,089	-	550.05	15.95	175	553.05	554.20	50	25,400.00	9,500	12.75	12.05	5,525	-6.90	12.05	20.22	1,17,705	3,370	2,16,036
	13,559	-172	702	-	505.00	17.70	200	504.65	505.80	200	25,450.00	8,575	15.05	15.15	4,350	-7.60	15.05	19.60	46,934	477	55,019
	1,14,585	656	10,311	14.96	458.90	16.90	300	458.10	459.10	25	25,500.00	5,175	18.05	18.10	1,850	-8.00	18.10	18.99	1,69,275	-896	3,01,327
	18,124	-224	1,026	13.21	410.00	15.40	375	411.50	412.45	50	25,550.00	825	21.75	21.80	3,475	-8.80	21.75	18.37	63,239	3,469	61,073
	95,023	532	8,477	14.37	368.40	16.55	150	368.35	369.15	225	25,600.00	1,925	26.15	26.25	4,525	-9.50	26.20	17.79	1,34,094	10,374	1,85,854
	16,168	-91	3,228	14.44	324.10	15.90	725	324.00	324.75	650	25,650.00	4,950	32.05	32.15	300	-10.40	32.05	17.32	67,012	2,999	58,231
	1,36,668	2,959	30,604	14.93	282.35	15.90	25	282.15	282.70	725	25,700.00	2,775	39.95	40.10	1,900	-10.85	39.90	16.94	1,66,479	14,625	2,57,485
	26,095	76	23,408	14.06	240.85	13.00	400	240.20	240.65	250	25,750.00	500	50.30	50.35	25	-12.10	50.30	16.60	1,01,900	14,727	84,253
	1,93,751	4,176	1,32,651	14.26	203.55	12.05	875	203.10	203.55	125	25,800.00	2,450	62.75	62.95	1,125	-13.05	62.95	16.34	2,80,138	36,467	2,64,503
	80,381	9,138	1,16,717	14.37	170.25	11.35	275	169.90	170.25	450	25,850.00	1,275	79.20	79.40	1,825	-14.75	79.35	16.29	1,62,291	17,524	1,09,716
	2,37,872	58,868	5,07,307	14.43	139.60	9.25	50	139.40	139.65	300	25,900.00	125	89.15	89.35	1,875	-15.55	89.15	16.19	4,96,237	97,717	2,58,712
	1,19,969	43,236	3,46,397	14.43	112.95	8.55	350	112.65	112.85	175	25,950.00	50	120.20	120.40	100	-18.35	120.45	15.93	2,08,774	43,071	76,797
	3,17,629	49,025	4,76,584	14.27	89.00	7.00	575	88.80	89.00	1,575	26,000.00	125	146.40	146.60	100	-19.75	146.55	15.86	1,97,470	24,640	1,46,906
	76,558	19,042	1,47,529	14.15	68.40	5.55	2,925	68.20	68.35	100	26,050.00	175	176.05	176.35	325	-22.55	175.55	16.08	31,198	2,939	14,280
	1,45,974	22,125	2,29,163	14.11	51.15	3.50	725	51.00	51.15	2,325	26,100.00	450	216.15	216.60	1,325	-21.35	210.80	16.11	37,699	7,679	19,033
	56,694	9,411	1,33,774	14.12	38.10	2.45	1,825	38.20	38.30	3,225	26,150.00	175	248.75	246.35	425	-24.65	245.50	16.58	4,545	1,250	3,724

Tab 3. Nifty data collected around 11:30 a.m. dated 24-9-24 from <https://www.nseindia.com/option-chain>

OI	CHNG IN OI	VOLUME	IV	LTP	CHNG	BID QTY	BID	ASK	ASK QTY	STRIKE	BID QTY	BID	ASK	ASK QTY	CHNG	LTP	IV	VOLUME	CHNG IN OI	OI
12,637	-674	2,790	13.94	306.70	20.60	100	303.40	310.40	25	25,450.00	3,375	13.60	13.65	1,725	-8.65	13.60	19.36	1,99,760	6,762	61,304
1,11,410	-2,519	35,282	13.96	461.85	19.85	200	462.00	463.05	75	25,500.00	1,125	16.40	16.45	3,125	-9.60	16.50	18.74	5,51,858	9,096	3,11,319
18,108	-240	3,771	13.98	415.00	20.40	50	415.00	415.85	50	25,550.00	5,325	19.25	19.30	2,650	-11.25	19.30	18.05	1,93,978	4,548	62,152
90,052	-4,439	31,357	14.57	369.45	17.60	50	368.75	369.45	200	25,600.00	1,450	23.00	23.05	1,425	-12.65	23.05	17.37	5,07,421	35,402	2,10,882
14,480	-1,779	11,513	14.15	323.50	15.30	750	323.70	324.40	25	25,650.00	1,350	28.35	28.45	3,700	-14.10	28.35	16.84	2,97,490	6,291	61,523
1,32,654	-1,055	1,14,253	14.18	281.45	15.00	825	281.60	281.95	25	25,700.00	1,600	35.05	35.15	2,650	-15.60	35.15	16.37	6,95,609	19,134	2,61,994
24,426	-1,593	63,719	13.79	239.50	11.65	75	239.35	239.85	275	25,750.00	2,025	44.10	44.20	325	-18.20	44.20	16.05	3,45,218	18,969	88,495
1,91,047	1,472	4,52,210	13.90	201.00	9.50	275	200.80	201.00	1,250	25,800.00	1,225	55.40	55.55	1,900	-20.60	55.40	15.62	9,43,295	27,880	2,55,916
77,960	6,717	3,48,252	13.74	165.80	6.90	25	166.00	166.15	225	25,850.00	675	70.75	70.85	75	-23.30	70.80	15.47	5,51,099	20,055	1,12,247
2,16,373	37,369	16,39,188	13.68	134.65	4.30	500	134.70	134.80	275	25,900.00	25	89.10	89.15	25	-25.60	89.10	15.32	17,72,180	1,53,063	3,13,458
1,41,118	64,385	14,67,551	13.56	106.35	1.95	275	106.15	106.35	1,000	25,950.00	50	110.20	110.40	900	-28.40	110.40	15.16	11,04,794	85,956	1,19,882
3,64,887	96,283	21,86,674	13.41	82.20	0.20	1,275	82.05	82.20	75	26,000.00	225	136.15	136.40	450	-30.20	136.10	15.15	12,23,771	82,295	2,04,651
82,449	24,933	6,36,560	13.34	61.50	-1.35	25	61.45	61.50	75	26,050.00	550	165.80	166.20	1,550	-31.90	166.20	15.00	1,95,840	9,909	21,250
1,72,608	48,759	8,89,446	13.25	44.90	-2.75	375	44.90	45.00	8,700	26,100.00	350	199.60	199.90	150	-32.40	199.75	15.14	2,23,655	16,660	28,014
67,130	19,847	5,53,262	13.24	32.50	-3.15	1,550	32.45	32.50	6,750	26,150.00	200	236.60	237.10	250	-33.15	237.00	15.40	44,439	4,975	7,449
2,45,513	50,461	10,95,838	13.26	23.20	-2.90	7,025	23.10	23.20	11,325	26,200.00	500	276.65	277.30	75	-33.50	277.30	15.76	75,794	8,547	15,696
60,079	2,237	5,40,093	13.51	16.90	-2.85	12,000	16.80	16.90	11,525	26,250.00	50	320.70	321.40	200	-30.75	324.55	15.98	7,950	386	1,559
1,47,038	26,687	7,60,950	13.81	12.25	-2.60	13,975	12.20	12.25	775	26,300.00	200	365.80	366.65	200	-29.55	368.15	16.75	19,211	1,842	4,746

Tab 4. Nifty data collected around 11:30 a.m. dated 24-9-24 from <https://web.sensibull.com/home>

CALLS					PUTS				
OI Chg%	OI-lakh	Call OI	LTP	Strike ↓	IV	LTP	Put OI	OI-lakh	OI Chg%
-11%	3.6		326.25	25650	15.6	28.45		15.3	11%
-0.8%	33.2		281.05	25700	15.1	35.15		65.6	8%
-4.5%	6.2		238.35	25750	14.7	44.45		22.0	27%
1%	47.9		200.55	25800	14.3	55.90		63.5	11%
10%	19.5		165.05	25850	14.1	71.10		28.0	21%
23%	54.9		134.45	25900	13.8	89.00		77.9	94%
83%	35.1		105.50	25950	13.5	110.60		29.9	255%
37%	91.8		81.65	26000	13.4	136.80		51.5	68%
45%	20.9		60.80	26050	13.2	166.35		5.5	95%
41%	43.5		44.50	26100	13.0	200.40		6.9	142%
48%	17.5		32.15	26150	13.0	237.40		1.9	210%
24%	60.6		22.75	26200	13.0	278.00		3.9	119%





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Tab 5. Nifty data collected around 13:30 p.m. dated 24-9-24 from <https://www.nseindia.com/option-chain>

OI	CHNG IN OI	VOLUME	IV	LTP	CHNG	BID QTY	BID	ASK	ASK QTY	STRIKE	BID QTY	BID	ASK	ASK QTY	CHNG	LTP	IV	VOLUME	CHNG IN OI	OI
12,920	-1,111	5,513	-	324.00	36.10	200	324.35	326.35	350	25,430.00	6,400	11.25	11.35	9,150	-11.35	11.30	18.55	2,30,401	1,447	81,395
1,06,581	-7,348	56,868	-	478.10	36.10	200	477.35	478.40	275	25,500.00	7,075	13.35	13.45	9,400	-12.75	13.35	18.18	7,80,326	-2,652	2,99,571
17,587	-761	5,577	8.83	429.65	35.05	100	426.65	427.60	200	25,550.00	1,000	15.60	15.65	7,975	-14.90	15.65	17.43	2,71,487	1,722	59,326
78,034	-16,457	58,392	11.68	380.00	28.15	100	379.85	380.65	25	25,600.00	10,300	18.65	18.75	5,125	-17.05	18.65	16.77	7,35,487	17,184	1,92,664
13,994	-2,265	16,528	12.40	335.85	27.65	75	335.90	336.65	225	25,650.00	1,275	22.90	22.95	200	-19.50	22.95	16.19	4,22,556	8,902	64,134
1,20,125	-13,584	1,67,127	12.73	290.95	24.50	350	290.25	290.90	150	25,700.00	525	28.55	28.60	575	-22.20	28.55	15.68	10,05,923	8,692	2,51,552
25,804	-215	97,097	12.53	247.85	20.00	300	247.30	247.85	350	25,750.00	775	35.60	35.70	2,075	-26.65	35.75	15.26	5,09,512	20,340	89,866
1,89,556	-19	6,79,373	12.45	207.70	16.20	650	207.30	207.65	25	25,800.00	1,775	46.30	46.40	375	-29.60	46.40	14.91	13,80,849	25,789	2,53,825
84,181	12,938	5,26,745	12.53	170.90	12.00	275	170.90	171.25	250	25,850.00	400	60.00	60.05	1,025	-34.05	60.05	14.73	8,24,247	17,622	1,09,814
2,29,693	50,689	25,20,525	12.61	138.40	8.05	75	138.40	138.60	125	25,900.00	1,100	76.80	76.95	325	-37.80	76.90	14.61	28,44,009	1,46,018	3,06,413
1,63,184	86,451	22,93,225	12.54	108.75	4.35	200	108.55	108.75	1,050	25,950.00	300	96.65	96.85	1,050	-42.10	96.70	14.45	17,16,392	93,438	1,27,164
3,95,948	1,27,344	31,95,441	12.56	83.55	1.55	300	83.55	83.70	1,025	26,000.00	550	121.85	122.10	850	-44.25	122.05	14.43	18,32,574	87,404	2,09,760
88,573	31,057	9,24,281	12.47	63.25	0.40	975	63.15	63.30	3,100	26,050.00	525	150.00	150.25	350	-47.80	150.30	14.47	2,85,557	11,833	23,174
1,73,719	49,870	13,11,641	12.39	44.85	-2.80	550	44.75	44.85	1,000	26,100.00	1,025	181.10	181.40	1,450	-50.35	181.80	14.55	3,37,586	19,842	31,196
75,528	28,245	7,76,570	12.37	32.30	-3.35	200	32.45	32.50	375	26,150.00	275	218.85	219.35	150	-51.05	219.10	14.76	60,376	4,768	7,242
2,42,719	47,667	15,41,364	12.42	22.10	-4.00	5,425	22.10	22.20	1,875	26,200.00	100	257.60	258.10	100	-52.80	258.00	15.06	1,11,815	7,883	15,032
73,335	15,493	7,33,266	12.53	15.45	-4.30	1,125	15.45	15.50	3,250	26,250.00	325	302.05	302.75	25	-51.60	303.70	15.49	11,160	254	1,427
1,60,042	39,691	10,73,357	12.72	10.30	-4.55	14,700	10.30	10.35	10,100	26,300.00	300	347.05	347.85	500	-48.35	349.35	16.38	27,145	1,874	4,778

Tab 6. Nifty data collected around 13:30 p.m. Dated 24-9-24 from <https://web.sensibull.com/home>

CALLS						PUTS			
OI Chg%	OI-lakh	Call OI	LTP	Strike ↓	IV	LTP	Put OI	OI-lakh	OI Chg%
-14%	3.5		346.25	25650	15.5	22.15		16.2	18%
-11%	29.9		301.00	25700	14.9	27.30		63.0	3.8%
-2%	6.4		256.95	25750	14.4	34.50		22.6	30%
-0.3%	47.3		215.95	25800	14.0	43.80		63.8	12%
16%	20.7		179.00	25850	13.7	56.65		27.6	20%
25%	56.0		145.40	25900	13.4	72.75		80.8	101%
106%	39.4		115.00	25950	13.1	91.85		32.6	287%
45%	97.4		89.00	26000	13.0	115.35		53.4	75%
53%	22.0		66.10	26050	12.8	143.10		5.8	105%
40%	43.2		47.80	26100	12.6	175.00		7.8	176%
59%	18.8		33.55	26150	12.4	210.60		1.8	196%
23%	59.9		23.20	26200	12.4	250.75		3.8	112%
25%	10.1		15.00	26250	12.4	200.00		0.2	10%

Tab 7. Nifty data collected around 15:10 p.m. dated 24-9-24 from <https://www.nseindia.com/option-chain>

OI	CHNG IN OI	VOLUME	IV	LTP	CHNG	BID QTY	BID	ASK	ASK QTY	STRIKE	BID QTY	BID	ASK	ASK QTY	CHNG	LTP	IV	VOLUME	CHNG IN OI	OI
12,230	-1,401	5,097	10.79	460.30	0.00	200	460.00	469.70	200	25,430.00	4,225	10.15	10.20	4,125	-12.55	10.10	17.04	3,21,302	12,167	66,099
1,00,838	-13,091	78,768	7.70	439.95	-2.05	50	440.55	441.60	200	25,500.00	100	14.55	14.60	2,325	-15.95	14.60	16.40	3,54,129	1,014	58,618
17,248	-1,100	8,466	10.65	390.00	-4.60	175	393.20	393.95	25	25,550.00	2,200	14.55	14.60	2,325	-15.95	14.60	16.40	3,54,129	1,014	58,618
73,398	-21,093	75,836	11.91	346.45	-5.40	175	346.55	347.25	25	25,600.00	6,275	17.85	17.95	2,800	-17.80	17.90	15.76	9,65,531	17,642	1,93,122
13,779	-2,480	21,735	11.86	308.15	-0.05	75	307.35	308.00	375	25,650.00	3,625	21.80	21.90	3,825	-20.50	21.95	15.14	5,50,620	7,127	62,359
1,19,075	-14,634	2,40,712	12.31	258.00	-8.45	150	257.85	258.40	175	25,700.00	2,600	28.25	28.35	2,000	-22.45	28.30	14.58	13,31,398	-1,974	2,40,886
23,501	-2,518	1,21,011	11.93	215.65	-12.20	100	215.20	215.65	950	25,750.00	475	36.70	36.80	1,625	-25.60	36.80	14.15	6,99,384	18,996	88,522
1,82,368	-7,207	8,93,284	11.98	177.00	-14.50	200	176.50	176.85	125	25,800.00	775	47.95	48.05	625	-27.90	48.10	13.82	18,28,964	28,442	2,56,478
76,675	5,432	6,85,760	12.00	142.20	-16.70	400	141.90	142.20	650	25,850.00	300	63.10	63.20	125	-31.05	63.05	13.63	11,12,420	17,706	1,09,898
1,93,745	14,741	33,13,075	11.97	110.90	-19.45	200	110.90	110.90	150	25,900.00	200	82.30	82.45	125	-32.25	82.45	13.43	38,68,168	1,37,129	2,97,524
1,47,255	70,522	32,73,313	11.89	84.10	-20.30	1,350	84.15	84.30	100	25,950.00	175	102.15	102.25	50	-36.65	102.15	13.34	25,14,844	90,755	1,24,481
3,91,732	1,23,128	48,16,517	11.81	64.55	-17.45	725	64.45	64.60	900	26,000.00	625	132.75	133.00	775	-33.55	132.75	13.28	28,08,708	1,07,246	2,29,602
85,891	28,375	13,57,550	11.71	45.80	-17.05	1,550	45.65	45.80	1,625	26,050.00	100	160.40	160.70	125	-37.40	160.70	13.30	4,60,726	11,433	22,774
1,75,555	51,706	19,32,813	11.67	29.65	-18.00	4,575	29.60	29.70	850	26,100.00	400	200.15	200.55	200	-32.15	200.00	13.33	5,31,217	17,565	28,919
78,050	30,767	10,94,324	11.63	21.00	-14.65	5,200	21.00	21.10	6,100	26,150.00	350	234.60	235.05	50	-34.80	235.35	13.50	92,787	4,887	7,361
2,33,701	38,649	21,49,677	11.70	13.05	-13.05	4,950	13.05	13.15	7,100	26,200.00	75	283.30	283.70	700	-27.50	283.30	13.88	1,81,614	6,650	13,799
94,469	36,627	10,68,501	11.77	8.85	-10.90	25,075	8.85	8.95	17,925	26,250.00	25	322.60	323.10	500	-34.80	320.50	14.39	17,892	319	1,492
1,53,511	33,160	16,50,955	12.03	5.85	-9.00	5,950	5.85	5.90	16,500	26,300.00	550	370.05	370.75	50	-29.15	368.55	15.31	38,424	767	3,671





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Tab 8. Nifty data collected around 15:10 p.m. dated 24-9-24 from <https://web.sensibull.com/home>

CALLS					PUTS				
OI Chg%	OI-lakh	Call OI	LTP	Strike ↓	IV	LTP	Put OI	OI-lakh	OI Chg%
-15%	3.4		311.00	25650	14.6	21.90		15.5	13%
-11%	29.7		267.05	25700	14.0	27.40		60.5	-0.3%
-10%	5.8		223.75	25750	13.5	35.15		22.1	27%
-3%	46.0		184.10	25800	13.2	45.95		62.7	10%
8%	19.2		149.05	25850	12.9	60.45		27.2	18%
9%	48.9		117.50	25900	12.6	78.20		73.7	84%
91%	36.7		89.95	25950	12.3	100.35		28.8	241%
45%	97.1		66.30	26000	12.1	127.10		55.9	83%
48%	21.3		47.05	26050	11.9	158.40		5.4	89%
40%	43.4		32.40	26100	11.8	194.00		6.9	143%
60%	18.9		22.00	26150	11.8	232.75		1.8	198%
19%	57.8		14.95	26200	11.9	275.35		3.4	90%
60%	14.4		0.75	26250	12.0	271.65		0.4	71%

Tab 9. Nifty 50 closing values on 24-9-24

Nifty50							
Symbol	Last	Chg	Chg%				
HCLTEC	1,775.60	22.80	1.30%	TATAMC	977.30	5.50	0.57%
HINDAL	717.85	27.30	3.95%	NESTLE	2,696.40	-28.75	-1.05%
INFY	1,898.60	2.15	0.11%	HINDU	2,950.55	-78.00	-2.58%
TECHM	1,637.10	29.95	1.86%	BPCL	339.15	1.05	0.31%
EICHER	4,876.90	-2.65	-0.05%	TATAST	160.53	6.54	4.25%
IOC	169.89	0.16	0.09%	ICICIBA	1,318.60	-3.30	-0.25%
TCS	4,271.30	2.80	0.07%	WIPRO	539.55	4.65	0.87%
GAIL	222.68	2.35	1.07%	HDFCBI	1,768.05	8.25	0.47%
COALIN	504.30	3.70	0.74%	BAJAJ	12,443.65	104.70	0.85%
HEROM	6,126.30	-64.25	-1.04%	SBILIFE	1,864.35	-55.80	-2.91%
UPL	603.75	10.95	1.85%	MARUT	12,738.60	55.50	0.44%
ONGC	299.45	4.00	1.35%	TITAN	3,784.90	-35.20	-0.92%
BRITAN	6,203.15	-8.05	-0.13%	SHREEK	25,911.65	-46.45	-0.18%
DIVISL	5,375.80	2.95	0.05%	SBIN	798.25	-3.60	-0.45%
CIPLA	1,637.55	-20.60	-1.24%	ADANIP	1,456.65	0.50	0.03%
KOTAK	1,914.70	-20.00	-1.03%	JSWSTE	989.70	7.60	0.77%
ITC	515.25	-1.70	-0.33%	SUNPH	1,868.10	5.40	0.29%
LT	3,791.60	3.90	0.10%	ASIANR	3,248.40	-29.05	-0.89%
				RELIAN	2,978.75	-8.00	-0.27%
				DRREDI	6,650.35	-4.10	-0.06%
				GRASIM	2,619.30	-47.60	-1.78%





Tab 10

Security Name	Industry	Weightage (%)
HDFC Bank Ltd.	Financial Services	11.02
Reliance Industries Ltd.	Oil, Gas & Consumable Fuels	9.13
ICICI Bank Ltd.	Financial Services	7.73
Infosys Ltd.	Information Technology	6.27
ITC Ltd.	Fast Moving Consumer Goods	4.14
Tata Consultancy Services Ltd.	Information Technology	4.12
Larsen & Toubro Ltd.	Construction	3.87
Bharti Airtel Ltd.	Telecommunication	3.80
Axis Bank Ltd.	Financial Services	2.99

Fig 1. The above nifty stocks charts(1min) taken from <https://www.tradingview.com/> dated 24-9-24

Fig 2. Above Infosys was flat in till 2 p.m. then after wards it pulled the nifty upward



Fig 3. Above HDFC bank pulled nifty upward in early morning later downward and then upward again



Fig 4. Above ITC was volatile though out the day i.e. pulling up then down then up then down so on





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Fig 5. Above AIRTEL bank pulled nifty upward in early morning later downward and then upward again

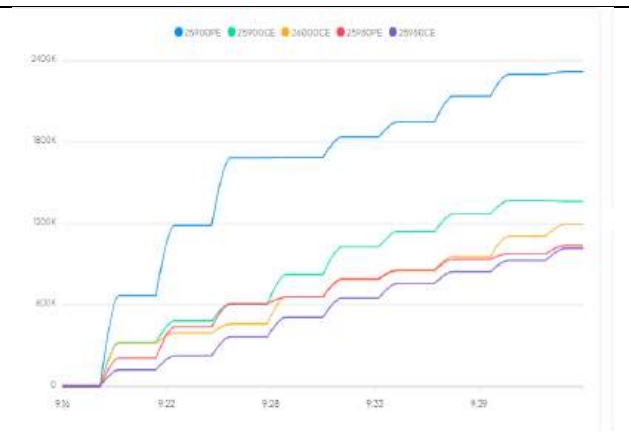


Fig 6. Nifty data collected around 9:50 a.m. dated 24-9-24 from <https://tradingtick.com/options/trending-o-strike>



Fig 7. Nifty data collected around 9:50 a.m. dated 24-9-24 from <https://www.tradingview.com>

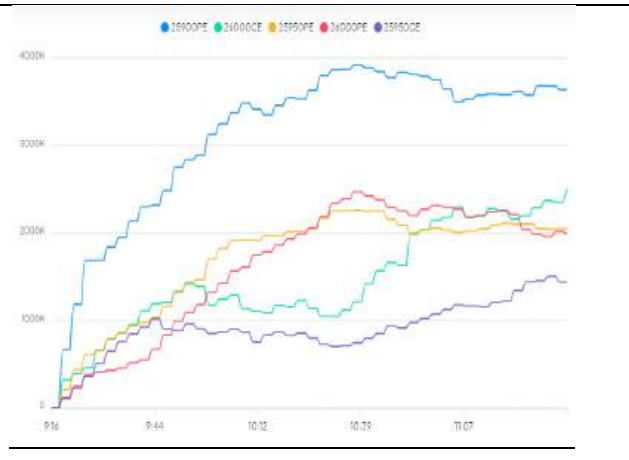


Fig 8. Nifty data collected around 11:30 a.m. dated 24-9-24



Fig 9. Nifty 5min chart data collected around 11:30 a.m. dated 24-9-24 from <https://www.tradingview.com>



Fig 10. Nifty data collected around 13:30 p.m. dated 24-9-24 from <https://www.tradingview.com>





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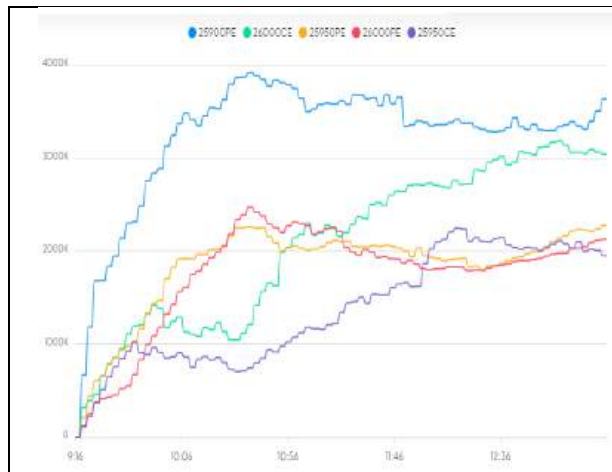


Fig 11. Nifty data collected around 13:30 p.m. dated 24-9-24

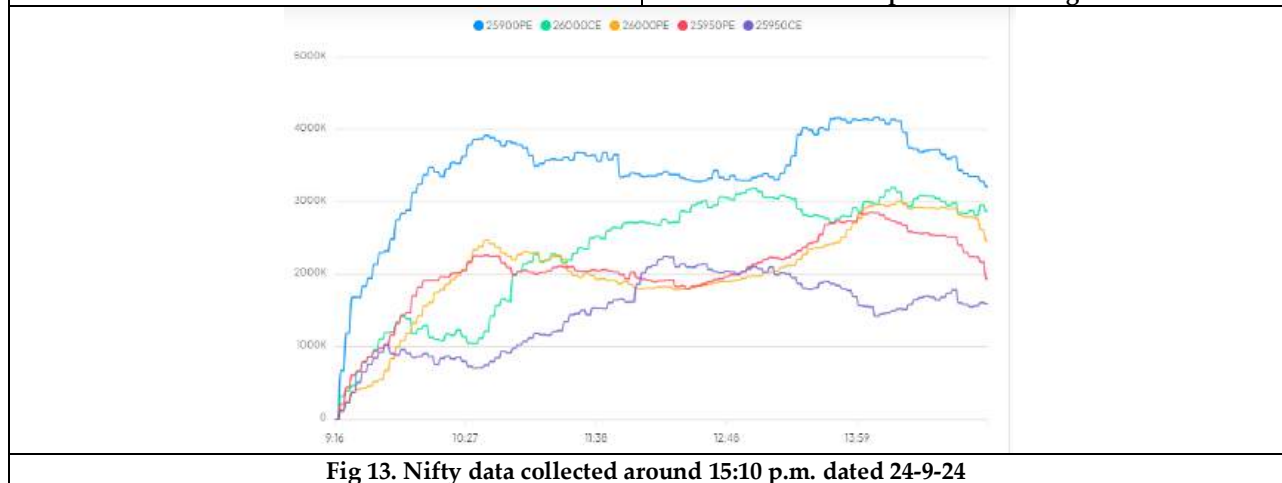
Fig 12. Nifty data collected around 15:10 p.m. dated 24-9-24 from <https://www.tradingview.com>

Fig 13. Nifty data collected around 15:10 p.m. dated 24-9-24





Methods of Machine Learning Used to Identify Industrial IOT Network Attacks

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ABSTRACT

Automation and industrial processes have advanced significantly as a result of the deployment of 5G technology and the use of the Industrial Internet of Things (IIoT). But the proliferation of connected devices in the context of IIoT networks enabled by 5G has also increased the potential of cyber attacks against industrial systems. Thus, in the era of 5G, protecting IIoT networks has become crucial for guaranteeing the availability, integrity, and safety of vital industrial systems. In the context of the 5G-enabled IIoT, this article provides a thorough investigation of machine learning techniques for identifying and thwarting network assaults. IIoT, or the internet of things for industrial applications, deals with large-scale networks. The term "Industrial Internet of Things" refers to the combination of networked sensors, computer systems, and manufacturing processes. Another major difficulty is keeping the IIoT network secure and protecting user privacy. By utilising diverse Artificial Intelligence algorithms, it is feasible to safeguard data and the IIoT network from potential assaults. In addition to applying machine learning (ML) techniques for attack detection and selecting an appropriate platform, this study offers a methodical survey of potential assaults on industrial IoT networks.

Keywords: IoT edge, machine learning, cloud computing, industrial IoT, and IoT applications





INTRODUCTION

The Internet of Things, or IoT, is an unseen network connecting many items that are dispersed throughout several directions. A subset of the Internet of Things called "Industrial Internet of Things" (IIoT) is dedicated to the special needs of industrial applications like manufacturing, utilities, and the oil and gas industry. a generic IIoT network architecture In particular, IIoT pertains to all networked sensors, devices, and other gadgets that function in tandem with industrial packages-such as manufacturing and electricity management—to form a comprehensive service network that facilitates the use of advanced automation. Because this connectivity allows for performance improvements throughout the manufacturing chain, it makes it possible to collect, share, and assess data. Additionally, it enables the manufacturing industry to achieve enormous innovation leaps, get a healthy amount of extraversion, and expand sports that were previously not achievable. It is highlighted in [8] that the entire delivery chain's transformation into an integrated and fully automated manner based entirely on IIoT assumes a more cautious approach to threats associated with commercial IoT structures. The authors provide a detailed inventory of potential attacks at the layer of five useful tiers of Industrial IoT, with the first three falling under the category of operational technologies (OT) and the other two under information technologies (IT). In [1] order to implement IIoT physical strategies, which comprise embedded devices, actuators, sensors, automobiles, and transmitters, the functional level primarily consists of structures. At this point, an attacker must have a thorough understanding of the IIoT design system in order to gain access to active device specs, engineering plans, and specific statistics. about their capacity for installation and operation. In the second level, programmable common-sense controllers (percent), gateways, and dispensed manipulate structures (DCS) are among the specialized systems that interact with and manage the first-degree devices. Attackers at this level aim to control the flow of verbal communication and obstruct legitimate dialogue between the two layers.

The third relevant degree is SCADA, which includes all related industrial automation and system telemetry manipulation. This includes master stations, interfaces between IP-connected devices and humans, and device acquisition records. A lot of SCADA-level attacks rely on methods for creating IP packets with fictitious characteristics, such as the source address, to conceal the sender's identity and lead the recipient to believe the packet is from a legitimate community member. Enterprise planning services, such as office packages, intranets, internet, and mail services, make up the fourth usable degree. At this level, targeted attacks take advantage of undiscovered security holes in services and introduce malicious code where the utility requires valid information from the user in order to grant administrator access. SCADA level with all related business automation manipulation and remote measurement structures such as information gathering devices, grip phases, and IP-speaking human-device interfaces. In [2] Several SCADA-level attacks rely on techniques to create IP packets with fictitious characteristics, such as the source address, to conceal the packet sender's identity and lead the recipient to believe the packet is from a legitimate network user. Business planning is included in the fourth functional degree. Workplace programmes, intranet, mail services, and the online were among the services offered here. At this point, attacks focus on the most known or undiscovered weaknesses in these products and introduce malicious software, which expects legitimate customer data to gain administrative access privileges. The fifth functional level comprises advanced services like analytics and data mining techniques managed by the organization. initiatives, as well [3] as cloud computing services. At this stage, attacks might take the form of basic malevolent acts like spoofing and interception, as well as more sophisticated ones like hostile attacks.

REVIEW OF THE LITERATURE

The use of cloud computing has grown in popularity recently. The business strategies employ the customised data centres to offer low-cost infrastructure solutions. Cloud computing offers a wide range of Internet services. Utilising a variety of internet resources, cloud computing helps individuals and organisations cut down on infrastructure expenses. Support Vector Machine, Naive Bayes, Decision Tree, K closest neighbour, and Random Forests were the



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[4] five machine learning methods that were employed. Comparisons were made between the evaluation factors that mentioned recall, accuracy, precision, and F1 score. It has been noted that the SVM algorithm has a high accuracy rate while Naive Bayes has a low accuracy rate.

Widely dispersed end customers utilise services like Infrastructure as a service (IaaS), Software as a service (SaaS), and Platform as a service (PaaS). Therefore, Users do not need to own the cloud computing infrastructure in order to maintain control, expertise, or application deployment management. IDS, which can be either hardware or software, is used for the purpose of detecting unusual behaviour and reporting it to the administrative authorities. The system administrator was previously informed about the intrusion. James Anderson provided the definition of IDS in 1980. He conducted an analysis of server case records and access logs using collection techniques. Dorothy E. Denning developed the anomaly-based Intrusion Detection System (IDES) in 1986 using statistics. Teresa F. Lunt uses Artificial Neural Networks (ANN) for IDES boosting. At the University of California, a rule-based anomaly detector with mathematical analysis is developed by scholars of Wisdom & Sense. Davis presents the Distributed Intrusion Detection System (DIDS) in 1991, which is based on anomaly and signatures. To identify unidentified threats The Anomaly-based Intrusion Detection System (AIDS) compares incoming network data to previously derived patterns. Signature-based detection is employed. This is referred to as either misuse-based detection or knowledge-based detection. The idea that unusual network traffic might be malevolent is applied. By doing so, it becomes feasible to recognise the network activity as an anomaly, which prompts additional research to determine the type of traffic. Algorithms for machine learning (ML) perform well and are ideal for anomaly identification.

Target CPPS (such as SCADA, MES, ERP, etc.) is used to assist in capturing the network traffic traces (PCAP files). initially. The properties of two-way traffic flow are then extracted, including variables like packet length, packet inter arrival time, number of sent and received packets, and flow duration. The feature selection module applies the PCA technique for data mapping, allowing less/redundant features to be eliminated without erasing any data. With the aid of mapping data that is supplied to it, the detection engine generates an alert [5] on the malicious network traffic pattern. The feature selection module's stored dataset is used for timely retraining of the Machine Learning models used by the detection engine. The alert manager has done an analysis of the output from the detection engine. If an intrusion occurs that exceeds the predetermined security level, this then generates the warning. Here to identify attacks CPPS uses machine learning in Industry 4.0. PCAP files are used to capture network traffic traces from big semiconductor-based production factories. Eleven different kinds of supervised, unsupervised, and semi-supervised machine learning techniques are used to find anomalies in traffic networks. The simulation results for supervised algorithms show that they perform better than unsupervised and semi-supervised methods. The DT, K-NN, and RF algorithms are utilised with FPR of 0.001 and Precision, Recall, and accuracy of 0.999 to detect DDoS attacks. The unsupervised algorithms K-means and EM performed best, with recall > 0.9, FPR > 0.09, precision > 0.9, and accuracy of 0.95. After using the PCA method, performance marginally decreased (with variance retained at approximately 95%). Labelling of the data is not necessary in this case for supervised and unsupervised learning, because require human intervention, work, and a challenging undertaking.

Long short-term memory (LSTM), gated recurrent units (GRUs), and artificial neural networks (ANNs) can be employed with 99 % accuracy to categories Industrial IoT malware assaults. The accuracy of ANN is found to be 99%, while that of GRU and LSTM is 98%. At 0.98 for each, the F1 score and Cohen's Kappa are the same for every individual. For GRU, LSTM, and ANN, the IAUC-ROC values are 0.83, 0.84, and 0.85, respectively. The highest precision value for GRU is 0.99, whereas for LSTM and ANN, it is 0.98. For LSTM and GRU, the [6] recall value is 0.98, whereas for ANN, it is 0.99. Low precision and accuracy [7] assaults are referred to as difficult attacks, which the model recognises. These kinds of attacks cause the model's performance to decrease. Therefore, a two-level model must be created in order to identify difficult assaults in the context of industrial IoT. Because of this, the proposed work aims to create a two-level intrusion detection system (IDS) that detects IIoT threats and concentrates on countering them. Smart metres and sensors are the primary sources of massive traffic in the Industrial IoT network. The range and magnitude of the data will be broad. Given the wide range and volume of the data, normalisation and data preprocessing are done before first-level detection.





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Level 1 Identification: The difficult attacks in first level detection are labelled as benign or misclassified attacks, after which they were assigned to Level-2 detection.

Level 2 Detection: In level 2, tough IIoT assaults that are misclassified are found. Two models and DNN (trained using the upgraded dragonfly technique) are utilised for identification NSA. The Industrial Internet of Things offers numerous advantages (IIoT). Here, a two-level intrusion detection system based on deep learning is used to examine various applications and security challenges in the IIoT. The suggested model performs sophisticated detection at the second level after first separating difficult attacks in the first level detection. IoT and network datasets are used, along with a benchmark, to evaluate the model. The demonstration demonstrates the improved performance over the current system models. Using two-level IDS, better performance can be shown on novel or zero-day assaults. Additionally, this can be expanded to include specific contexts like machine-to-machine Internet of Medical Things (IoMT) and Machine-to-Machine (M2M) for device and data security.

A lightweight [8] prediction model based on random neural networks is presented for assessing the F1 score, recall, precision, and accuracy as performance metrics for attack detection in industrial IoT networks. Following that, a comparison is made between these parameters and artificial neural networks, decision trees, and traditional support vector machines. Based on the results, it is possible to attain an accuracy of 99.20% with a prediction time of 34.51 milliseconds and a learning rate of 0.01. Recall, precision, and F1 score are further performance metrics that are 99.13%, 99.11%, and 99.20%, respectively. When using this model instead of traditional machine learning techniques for IoT security, attack detection accuracy can be increased by an average of 5.65 percent. RaNN Compared to other strategies, the method suggested here can detect the attacks with a maximum accuracy of 99% and a forecast time of 34.51 milliseconds. Better RaNN outcomes are shown at a learning rate of 0.01. The suggested RaNN-based prediction model outperforms the existing DT, ANN, and SVM machine learning algorithms in terms of accuracy. It is also discovered that employing the RaNN-based method improves recall, F1 score, and precision parameter values. For detecting assaults at the edge for Industrial IoT, hardware deployment employing Raspberry Pi 4 and Intel Neural Computing Stick-based architecture is also mentioned. This model is evaluated using an open-source dataset called DS2OS.

The Taxonomy of Computers [9]

Machine learning (ML) methods have been utilised in IIoT-based systems to secure wireless communication. aids in the solution of many cybersecurity problems. The application of machine learning techniques is one of the most effective intrusion detection strategies. In order to obtain the best results, these methodologies are utilised to analyse data in real time across a variety of datasets. Numerous researchers today employ decision trees, supervised learning, deep learning, and adaptive learning techniques. There are two types of machine learning algorithms: supervised and unsupervised. The process of adding labels based on patterns and learning from labelled data is known as supervised learning. A straight forward and efficient learning technique, Naïve Bayes makes predictions about the final outcome by comparing the attributes of each class. It makes calculating probabilities easier. A potent supervised machine learning technique for solving regression and classification issues is the use of decision trees. They outperform the remaining categorization algorithms in terms of efficiency and speed. A straightforward model called logistic regression uses an observation to predict a class probability of 1. It works well for binary classification and, with a little more work, may also be expanded to multiclass classification. A machine learning technique called k-Nearest Neighbours is applied to address categorization problems. Both supervised and unsupervised learning approaches are relevant to machine learning.

KNN is a method for learning that is gradual and parameter-free, requiring no presumptions about the fundamental distribution of data. "Nonparametric" refers to the absence of assumptions regarding the basic data distribution. The quantity of neighbours is a crucial decision factor in KNN, which determines the number of nearest neighbours by k. Before coming to the right conclusion, it measures the difference between the input and its test data. A popular framework for machine learning and embedded systems, the Support Vector Machine (SVM) classifies both linear and nonlinear objects. It is especially advantageous for multidisciplinary environments in large data settings. Neural



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Networks (ANN) can be constructed from several kinds of neurons, whose sizes can vary from tens of thousands to millions down from ten. Unsupervised learning is a tool for efficiency gains, data structure analysis, and insight extraction. Data is divided into k-clusters, each with a known number of clusters, using an unsupervised method known as K-Means Clustering. A subset of machine learning techniques known as deep learning (DL) consists of many linked layers, where the input layer is the first layer and the output layer is the last. A neuron's signal intensity is influenced by factors including weight and activation function, and each covered layer is composed of several neurons. Convolutional neural networks (CNN), DNNs (convolutional neural networks), RNNs (recurrent neural networks), and DNNs (deep neural networks) are examples of supervised and unsupervised learning approaches. Unsupervised learning may be achieved through the use of auto encoders (AE), restricted Boltzmann machines (RBM), and generative adversarial networks (GAN). SVM, ANN, and DL are essential tools for machine learning and embedded systems, to sum up. These approaches are applicable to large-scale data categorisation challenges and are highly beneficial in multi domain applications.

Advantages of Machine Learning

Automation: Reduces the need for manual intervention in data analysis and decision-making processes.

Handling Large Data Sets: Capable of analyzing vast amounts of data quickly and efficiently.

Improved Accuracy: Often yields higher accuracy in predictions and classifications compared to traditional methods.

Adaptability: Can learn and adapt to new data over time, improving performance as more data becomes available.

Pattern Recognition: Excels at identifying complex patterns and relationships in data that might be missed by human analysis.

Personalization: Enables personalized experiences in applications like recommendations, marketing, and user interactions.

Scalability: Easily scales to accommodate increasing data sizes and complexity.

Disadvantages of Machine Learning

Data Dependency: Requires large amounts of high-quality data for training, which can be difficult to obtain.

Overfitting: Models can become overly complex and perform poorly on new, unseen data if not properly regulated.

Interpretability: Many machine learning models, especially deep learning, act as "black boxes," making it hard to interpret how decisions are made.

Computational Resources: Training sophisticated models often demands significant computational power and time.

Bias: Models can inherit biases present in the training data, leading to unfair or unethical outcomes.

Maintenance: Continuous monitoring and updating are needed to ensure model performance remains optimal as data evolves.

Implementation Costs: Initial setup and integration into existing systems can be costly and resource-intensive

CONCLUSION AND FUTURE SCOPE

The threat detection model for cloud services that uses machine learning techniques like Support Vector Machine and Native Bayes has been the subject of comparative study and performance analysis taking into account a range of performance parameters. Diverse machine learning techniques may be employed by Industry 4.0 CPPSs to detect DDoS assaults, and the efficacy of each technique can be evaluated. A hybrid IDS with federated learning may be developed in the future by combining the previously stated ML approaches. An effective way to discover new threats and zero-day vulnerabilities at the second level is to employ two-level intrusion detection systems (IDS) that are based on deep learning. These systems can identify complex assaults at the first level. Further data and device protection may be achieved with this model.



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Table 1: Comparison of the Application and Implementation Platform's ML Approaches

S.No.	Machine Learning approach used	Application	Platform
1	Support Vector Machine, Naïve Bayes, Decision Tree, K nearest neighbor and Random Forests	Cloud Computing	Google Co laboratory under Python3
2	DT, K-NN and RF	Industry 4.0	Python and Google co lab
3	Long short-term memory (LSTM), gated recurrent units (GRUs), and artificial neural networks (ANNs)	Industrial IoT	Python 3.8 using Keras, Tensor flow, and Scikit-Learn libraries.
4	Deep Learning-based two-level Intrusion Detection System	Industrial IoT	Python and Google co lab
5	DT, ANN and SVM machine learning algorithms	Industrial IoT	Anaconda Navigator and Python language

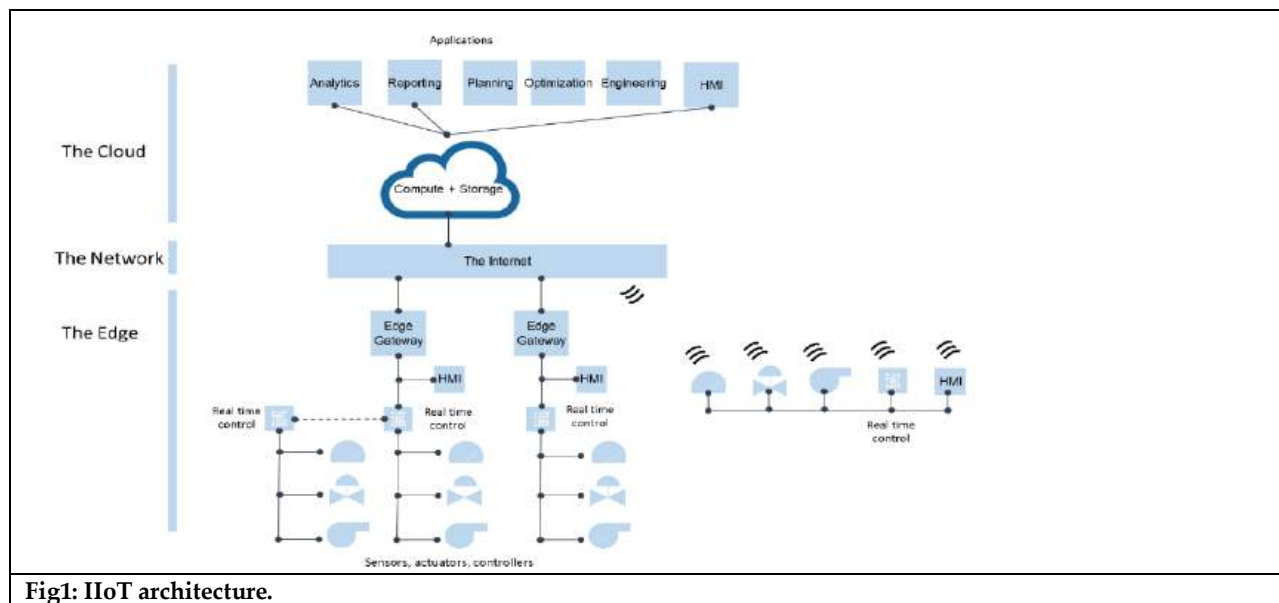


Fig1: IIoT architecture.





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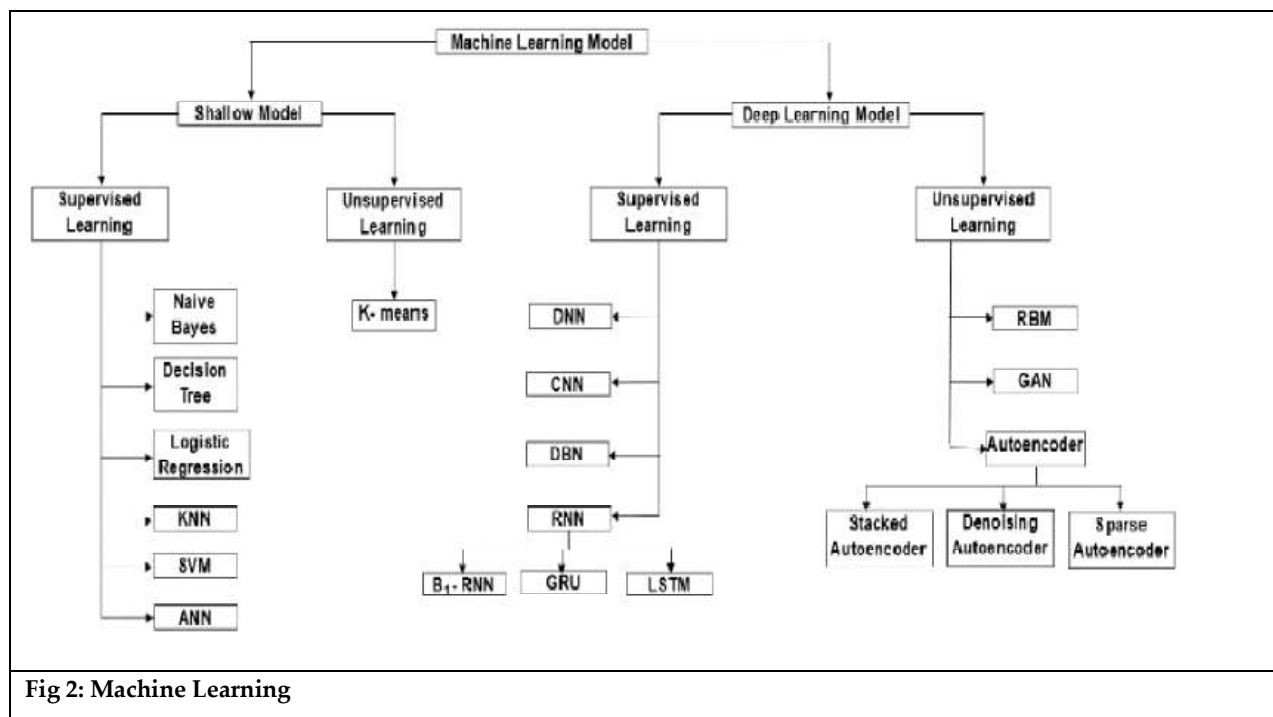


Fig 2: Machine Learning





Stock Market Noiseless Trading Strategies

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ABSTRACT

This paper explores the efficacy of a trading strategy for noiseless trading utilizing Renko charts with a traditional box size of 2, alongside the Triple Exponential Moving Average for periods of 5, 8, and 13, Relative Strength Index divergence, and volume analysis.

Keywords: Renko Chart, Noise less Trading, TEMA, RSI divergence.

INTRODUCTION

Swing trading is a popular trading strategy that aims to capture short to medium-term price movements in financial markets. Unlike day trading, which focuses on intraday price fluctuations, swing trading allows traders to hold positions for several days to weeks, capitalizing on the natural oscillations in asset prices. Given its potential for profitability, many traders seek effective methodologies that integrate technical indicators to refine their entry and exit points. In recent years, the use of Renko charts has gained traction among traders due to their unique ability to filter out market noise and focus solely on price movements. Unlike traditional candlestick charts, which represent price over time, Renko charts[1] are constructed based on price changes alone, thus providing a clearer view of market trends. This paper utilizes a traditional box size of 2, which strikes a balance between sensitivity to price movements and the minimization of false signals, thereby enhancing the effectiveness of swing trading strategies.

To complement Renko charts[2], we incorporate the Triple Exponential Moving Average (TEMA), calculated using periods of 5, 8, and 13. TEMA is known for its ability to reduce lag while providing a smoother representation of price trends. By employing multiple TEMA lines, traders can identify dynamic



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support and resistance levels, as well as potential entry and exit points that align with prevailing market trends. Another crucial aspect of this study is the inclusion of Relative Strength Index (RSI) divergence, a widely recognized indicator that helps traders identify potential reversals in market direction. RSI divergence occurs when the price action diverges from the RSI readings, signalling a weakening trend and potential reversal. This tool enhances the robustness of trading signals generated by Renko charts and TEMA[4], offering traders additional confirmation before making decisions.

Lastly, the integration of volume analysis[5] serves to reinforce trading decisions, as volume is a critical indicator of market strength. Increased volume accompanying price movements can signify the sustainability of trends, whereas declining volume may indicate potential reversals or corrections. By considering volume alongside price action and technical indicators, traders can achieve a more comprehensive understanding of market dynamics. This paper aims to provide a detailed analysis of the efficacy of swing trading strategies that leverage Renko charts[3], TEMA, RSI divergence[6], and volume analysis. Through empirical research, we will evaluate the performance of this multifaceted approach, offering insights and practical implications for traders seeking to optimize their strategies in today's dynamic financial markets. Renko charts the noise less charts Brick Size Calculation: The Renko charts are constructed using fixed brick sizes based on percentage price changes. Various brick sizes (e.g., 1%, 2%) are tested to identify the optimal value that balances signal clarity with sensitivity to price movements. No Time Factor: Renko charts are built only when the price moves by a set amount (brick size), filtering out noise from minor price fluctuations and focusing on trend reversals. Renko follows the price action and it independent of time A new brick is created when the price moves a specified price amount Absolute brick value plots according to specific brick size Log brick value plots according to percentage movement ATR brick value plots according to ATR value

METHODOLOGY

General brick sizes or percentage for short-, medium- and long-term trading are as follows

For short term normally 0.19% to 0.9 % is daily time frame

For medium term analysis 0.9% to 2.9% on daily time frame

For long term analysis 2.9% to 4.9% on daily time frame

For stocks 0.29%

For Nifty 29 Points or 0.16%

For Bank Nifty 49 Points or 0.16%

Thus, traditional box sizes provide a simple and consistent approach, while ATR-based [7] box sizes offer dynamic adjustments that enhance noiseless trading, especially in volatile environments.

Real time examples

Fig 1. Reliance futures April 2024 from <https://www.tradingview.com/chart/>

Buy 1 lot reliance future @ 2935 on 8th Apr as green brick are newly forming and RSI is at low 21 and sell @2970 on 9th Apr

Buy 1 lot reliance future @ 2908 on 25th Apr and RSI is at low 28 sell @2933 on 26th Apr

Fig 2. Reliance futures May 2024 from <https://www.tradingview.com/chart/>

May 8th no need buy as RSI is above 50

Buy 1 lot @2809 on 10th may also RSI divergence is indicating buy

And sell @2969 on 27th may also RSI is at 80 indicating sell

Fig 3. Reliance futures June 2024 from <https://www.tradingview.com/chart/>

3rd Jun no need buy as RSI is above 70





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4th Jun sell 1 lot @3035 also RSI 90 is indicating sell and buy on 5th Jun @2803 as brick are reversing on buy mode

No need to sell on 19 Jun as RSI bear slope is very less

Buy 1 lot @2809 on 25th June also RSI is 26 is indicating buy

Fig 4. Reliance futures July 2024 from <https://www.tradingview.com/chart/>
1st Jul sell 1 lot @3148 also RSI 90 is indicating sell

Fig 5. Reliance futures August 2024 from <https://www.tradingview.com/chart/>
30th Aug sell 1 lot @3050 also RSI 90 is indicating sell

Fig 6. Reliance futures September 2024 from <https://www.tradingview.com/chart/>
11th Sep buy 1 lot @2908 also RSI 20 is indicating buy

Fig 7. This is nifty Renko chart (ATR 14) on daily time frame

Also, RSI is divergence indicator is used to double confirm the trades

One can take short entry 4-06-24 as RSI is divergence and Renko bricks both are indicating so @ 22400

One can take long entry 21-08-24 as RSI divergence and Renko bricks both are indicating so @ 24500

Fig 8. This is Mothersonstock Renko chart of @ 1%

Also, RSI is divergence indicator is used to double confirm the trades

One can take short entry 3-9-24 as RSI is divergence and Renko bricks both are indicating so @ 196

One can take long entry 12-09-24 as RSI divergence and Renko bricks both are indicating so @ 184

RESULTS AND DISCUSSIONS

This summary outlines the trading activities and outcomes for Reliance Futures from April to September 2024, based on strategic entry and exit points informed by Renko charts and RSI indicators.

Fig 1: April 2024

- Buy Transaction: On April 8, 2024, 1 lot of Reliance futures was purchased at ₹2935. This decision was supported by the formation of green bricks on the Renko chart and a low RSI of 21, indicating a potential price reversal.
- Sell Transaction: The position was sold on April 9, 2024, at ₹2970, yielding a profit of ₹8750 per lot.
- Subsequent Buy Transaction: On April 25, 2024, another lot was bought at ₹2908, with the RSI at a low of 28, again signalling a favourable entry point.
- Sell Transaction: This lot was sold on April 26, 2024, at ₹2933, resulting in a profit of ₹6250

Fig 2: May 2024

- Market Analysis (May 8): No buy signal was indicated as the RSI was above 50.
- Buy Transaction: On May 10, 2024, 1 lot was purchased at ₹2809, supported by RSI divergence indicating a buying opportunity.
- Sell Transaction: The position was sold on May 27, 2024, at ₹2969, with the RSI reaching 80, indicating an overbought condition and yielding a profit of ₹40000.

Fig 3: June 2024

- Market Analysis (June 3): No buy signal was indicated as the RSI was above 70.
- Sell Transaction: On June 4, 2024, 1 lot was sold at ₹3035, supported by an RSI of 90.
- Buy Transaction: On June 5, 2024, 1 lot was purchased at ₹2803, as the Renko bricks indicated a reversal to buy mode.
- No Action (June 19): No sell action was taken as the RSI bear slope was minimal.





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- Buy Transaction: On June 25, 2024, another lot was bought at ₹2809 with the RSI at 26, indicating a favourable entry point.

Fig 4: July 2024

- Sell Transaction: On July 1, 2024, 1 lot was sold at ₹3148, with the RSI at 90, indicating a sell signal.

Fig 5: August 2024

- Sell Transaction: On August 30, 2024, 1 lot was sold at ₹3050, again supported by an RSI of 90.

Fig 6: September 2024

- Buy Transaction: On September 11, 2024, 1 lot was purchased at ₹2908, supported by a low RSI of 20, indicating a potential buying opportunity.

Analysis of intraday trading of fig 7 & 8

This analysis evaluates trades based on Renko charts and RSI divergence for both Nifty and Mothersonstock. The strategy employed is focused on confirming trade signals using both the Renko chart patterns and RSI divergence to identify potential reversals or trend continuations.

Nifty Renko Chart (ATR 14) - Daily Time Frame:

Short Entry:

- Date: 4th June 2024
- Entry Price: 22,400
- Reason for Entry: Both Renko bricks and RSI divergence indicated a bearish trend, providing a strong signal to enter a short position. The combination of a downtrend in the Renko chart, alongside an RSI divergence confirming weakening buying momentum, made this an optimal point to short Nifty.

Long Entry:

- Date: 21st August 2024
- Entry Price: 24,500
- Reason for Entry: Renko bricks indicated a bullish reversal, supported by an RSI divergence signalling upward momentum. This alignment provided a confirmation to take a long position, expecting a continued rise in price as market conditions strengthened.

Motherson Stock Renko Chart (1% Box Size):

Short Entry:

- Date: 3rd September 2024
- Entry Price: 196
- Reason for Entry: On this date, both Renko bricks and RSI divergence indicated a bearish trend reversal, suggesting a weakening of the stock price. The Renko chart's downward trend and the RSI's bearish divergence confirmed the decision to enter a short position.

Long Entry:

- Date: 12th September 2024
- Entry Price: 184
- Reason for Entry: A bullish reversal was identified through Renko bricks, accompanied by an RSI divergence confirming a likely uptrend. This offered a signal to go long, with the expectation that the price would rise from the current levels due to the stronger buying momentum.

Final Summary

Over a period of six months, an initial investment of ₹135,000 was made for swing trading in Reliance futures, utilizing a strategy based on Renko charts, RSI divergence, and technical indicators. The total profit generated from the trades executed during this period amounted to ₹233,250.

Key trades included:

- April 2024: Two successful buy-and-sell cycles, yielding profits of ₹8750 and ₹6250 respectively.
- May 2024: A highly profitable trade in May, where a buy at ₹2809 and sell at ₹2969 resulted in a profit of ₹40000.





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- June 2024: A well-timed sell at ₹3035 and buy at ₹2803 generated notable gains of Rs. 58000, supplemented by additional positions taken in late June.
- July 2024: A profitable sell at ₹3148 further contributed to the positive performance of Rs. 84750.
- August 2024: A sell at ₹3050 aligned with RSI indications, securing additional profits.
- September 2024: The final buy at ₹2908, supported by a favourable RSI signal. Resulted in profit of 35500

Financial Outcome

- Initial Investment: ₹135,000
- Total Profit: ₹233,250
- Return on Investment (ROI): The strategy yielded a return of over 172.7% within six months, showcasing the profitability and effectiveness of swing trading based on Renko charts and RSI divergence.

CONCLUSION

Over the six-month period, an initial investment of ₹135,000 in Reliance futures, utilizing a swing trading strategy based on Renko charts, RSI divergence, and technical indicators, yielded a total profit of ₹233,250. The resulting 172.4% return on investment (ROI) highlights the effectiveness of this swing trading method, which carefully blended price action analysis with momentum indicators. In conclusion, the success of this trading strategy reinforces the potential for technical analysis tools—specifically, Renko charts and RSI divergence—to consistently deliver profitable opportunities in futures trading. The framework established through this study can serve as a reliable model for traders seeking to enhance their decision-making process and optimize returns in volatile markets.

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7. Trading Price Action Trends: Technical Analysis of Price Charts Bar by Bar for the Serious Trader by Al Brooks

Table .1 Differences between traditional and ATR box sizes

Aspect	Traditional Box Sizes	ATR-Based Box Sizes
Brick Size	Fixed, set by the trader (e.g., ₹10 or ₹100)	Dynamic, adjusts based on market volatility (using ATR)
Volatility Adaptation	Does not adapt to volatility	Adapts to market volatility (higher volatility, larger boxes)
Sensitivity	May create too many bricks in volatile markets, or too few in calm markets	More responsive to changing volatility conditions
Noise Filtering	Fixed size may produce noise during high volatility	Better at filtering out noise in volatile markets
Best Suited For	Stable or consistent markets	Volatile or fast-changing markets





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Table.2

Date	Entry/Exit Price	Buy	Sell	Investment	Profit = diff(lot size)	Profit released in rupees
08-04-2024	2935.00	1		Rs. 135000		
09-04-2024	2970.00		1		(2970-2935)250	8750
25-04-2024	2908.00	1				
26-04-2024	2933.00		1		(2933-2908)250	6250
08-05-2024	2809.00	1				
27-05-2024	2969.00		1		(2969-2809)250	40000
04-06-2024	3035.00		1			
05-06-2024	2803.00	1			(3035-2803)250	58000
25-06-2024	2809.00	1				
01-07-2024	3148.00		1		(3148-2809)250	84750
30-08-2024	3050.00		1			
11-09-2024	2908.00	1			(3050-2908)250	35500
						233250

Fig 1. Reliance futures April 2024 from <https://www.tradingview.com/chart/>Fig 2. Reliance futures May 2024 from <https://www.tradingview.com/chart/>Fig 3. Reliance futures June 2024 from <https://www.tradingview.com/chart/>Fig 4. Reliance futures July 2024 from <https://www.tradingview.com/chart/>



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Fig 5. Reliance futures August 2024 from <https://www.tradingview.com/chart/>



Fig 6. Reliance futures September 2024 from <https://www.tradingview.com/chart/>

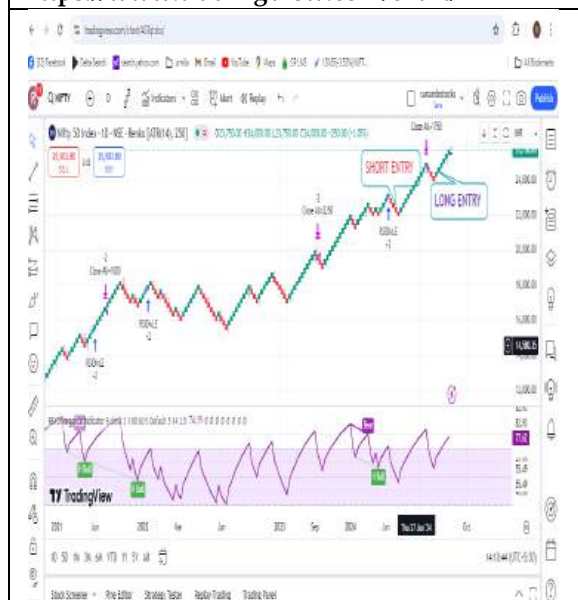


Fig 7. This is nifty Renko chart (ATR 14) on daily time frame



Fig 8. This is Motherstock Renko chart of @ 1%





Information Ethics in the Digital Era: Addressing Challenges and Obligations

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ABSTRACT

The digital age has ushered in significant transformations in the creation, dissemination, and consumption of information, presenting intricate ethical challenges that require attention from individuals, organizations, and society as a whole. Information ethics examines the moral principles that govern the management of information, concentrating on critical issues such as data privacy, intellectual property rights, misinformation, and equitable access to information. This paper investigates these pressing ethical challenges within the framework of the digital landscape, utilizing classical ethical theories like utilitarianism, deontology, and virtue ethics to identify potential solutions. Particular emphasis is placed on the obligations of information professionals who must navigate these ethical complexities, including the protection of data privacy, the promotion of equitable access, the fight against misinformation, and the defense of intellectual property rights. By thoroughly analyzing these topics, this paper aims to propose ethical frameworks and actionable strategies that can facilitate responsible information management in the digital age.

Keywords: Digital age, Information Ethics





INTRODUCTION

The digital age has significantly altered various facets of contemporary life, particularly in how information is generated, stored, shared, and consumed. With the advent of social media, cloud computing, and other digital technologies, the information landscape has been transformed, enhancing data accessibility while simultaneously introducing new ethical challenges. The proliferation of the internet, mobile devices, and digital communication tools has resulted in an unprecedented speed and scale of information availability. However, this digital transformation has also brought forth serious ethical issues concerning data privacy, misinformation, intellectual property, and disparities in access to technology. In this environment, information ethics has emerged as a vital discipline that investigates the moral implications of information management and dissemination. It aims to clarify the ethical duties of individuals and organizations in protecting data, ensuring the accuracy and reliability of information, and promoting responsible information practices.

Background

The notion of information ethics has developed in response to the growing significance of information in modern society. As digital technologies and the internet have rapidly advanced, they have introduced new ethical dilemmas. Prominent scholars like Luciano Floridi and Rafael Capurro have led the investigation into information ethics within this digital context, concentrating on topics such as privacy, autonomy, and the societal effects of information technologies. Information ethics scrutinizes the moral guidelines that govern the handling of information, encompassing aspects such as data collection, storage, sharing, and utilization. In today's digital landscape, information ethics encompasses domains like big data analytics, artificial intelligence, social media, and cloud computing. The ethical ramifications of these technologies have become pivotal in discussions surrounding data privacy, intellectual property, and the fair distribution of information resources. Additionally, the rise of misinformation and disinformation on digital platforms has sparked concerns regarding the reliability of information and the obligation of information professionals to ensure that users have access to accurate and credible content.

Objective

The main aim of this paper is to investigate the ethical challenges presented by the digital age in relation to information management. Specifically, the paper seeks to:

- Analyze the ethical theories applicable to information ethics in the digital context.
- Identify the primary challenges in information ethics, such as data privacy, the digital divide, misinformation, and intellectual property rights.
- Examine the ethical obligations of information professionals in tackling these challenges.
- Offer recommendations for encouraging responsible information management and cultivating an ethical digital environment.

Needs

As digital technologies advance, there is an increasing demand for ethical frameworks to tackle the challenges arising from digital transformation. The enhanced accessibility of information and the emergence of digital platforms have introduced new ethical dilemmas, particularly concerning data privacy, the proliferation of misinformation, and violations of intellectual property rights. Information professionals, along with organizations and governmental bodies, need well-defined ethical guidelines to effectively address these issues and guarantee responsible information management. The significance of information ethics is particularly pronounced given the rising role of digital data in decision-making across both private and public sectors. Technologies driven by data, such as artificial intelligence and machine learning, depend on extensive datasets, prompting inquiries into the ethical implications of data usage. It is crucial to ensure that information remains accurate, accessible, and utilized in a way that honors individuals' rights, thereby building trust in digital systems.



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Ethical Theories in the Context of the Digital Era

Ethical theories serve as essential frameworks for assessing the moral aspects of information management, guiding both individuals and organizations in making ethical choices in the digital age. Key ethical theories pertinent to information ethics include:

Utilitarianism: Developed by philosophers Jeremy Bentham and John Stuart Mill, utilitarianism is an ethical framework that prioritizes achieving the greatest good for the largest number of people. In the context of the digital age, utilitarianism can be applied to issues surrounding data privacy, accessibility, and intellectual property. For instance, when considering the ethics of user data sharing, utilitarian principles may weigh the societal benefits of such sharing (like advancements in healthcare or enhanced public safety) against the potential risks to individual privacy.

Deontology: Rooted in the philosophy of Immanuel Kant, deontological ethics focuses on the importance of duty, rules, and adherence to moral principles. Within the realm of digital information, deontology posits that certain actions are intrinsically right or wrong, irrespective of their outcomes. For example, infringing on data privacy could be deemed unethical according to deontological standards, even if such actions yield positive results, as they violate individuals' fundamental rights.

Virtue Ethics: Grounded in Aristotle's philosophy, virtue ethics emphasizes the moral character and virtues of individuals rather than specific rules or outcomes. For professionals in the information sector, this approach highlights the importance of integrity, fairness, and accountability in managing digital data. Virtue ethics advocates for the cultivation of moral character among those responsible for information management, ensuring that ethical considerations remain central to decision-making processes.

Social Contract Theory: The concept of social contract theory, articulated by philosophers such as Jean-Jacques Rousseau and John Locke, can be relevant to digital ethics by examining the unspoken agreements that exist between users and digital service providers. For example, individuals utilizing social media platforms often consent to share their personal information with the expectation that their privacy will be safeguarded. Ethical dilemmas emerge when these unspoken agreements are breached, particularly in situations where user data is disseminated without permission or when digital services capitalize on user information for financial gain.

Key Challenges in Information Ethics in the Digital Era

The digital age has brought forth numerous ethical dilemmas, especially concerning the collection, storage, dissemination, and utilization of information. The most critical ethical challenges include:

Data Privacy and Security: The extensive gathering of personal data by digital platforms, corporations, and governmental entities has sparked significant concerns regarding data privacy. Issues such as unauthorized data collection, breaches, and the misuse of personal information have become increasingly common. A primary challenge in the digital landscape is ensuring that individuals' privacy is honored and that their data is stored securely and used in an ethical manner.

The Digital Divide and Access to Information: The digital divide highlights the disparity between those who have access to digital technologies and the internet and those who do not. This divide raises ethical questions about the fair distribution of information and resources. In various regions globally, access to digital technologies is still limited, and the lack of information access further intensifies social and economic disparities.

Misinformation and Disinformation: The swift dissemination of misinformation and disinformation across digital platforms has become a notable ethical concern. False information can lead to severe repercussions, particularly in areas such as public health, politics, and social unity. The proliferation of misinformation erodes trust in institutions and can result in detrimental effects, including vaccine hesitancy and political turmoil. Ethical considerations in this domain involve finding a balance between free speech and the necessity to safeguard the public from inaccurate or misleading information.

Intellectual Property and Copyright in the Digital Age: The simplicity of sharing and reproducing digital content has brought significant concerns regarding intellectual property rights. Infringement of copyright is increasingly prevalent in the digital landscape, presenting challenges for content creators who strive to safeguard their work from unauthorized exploitation. Ethical considerations surrounding intellectual property necessitate a careful balance



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between the rights of creators and the demand for open access to information, especially within the realms of education and research.

Ethical Responsibilities of Information Professionals

Information professionals, such as librarians, archivists, data managers, and digital curators, are essential in tackling the ethical dilemmas presented by the digital age. Their roles encompass safeguarding data privacy, ensuring fair access to information, countering misinformation, and upholding intellectual property rights. These professionals must adeptly navigate intricate ethical terrains and make choices that reflect ethical standards while prioritizing the public good.

Safeguarding Data Privacy: A fundamental duty of information professionals is to protect the privacy of individuals whose data they oversee. This entails establishing strong data security protocols, maintaining transparency in data collection methods, and honoring individuals' rights to manage their personal information. Additionally, information professionals need to remain updated on changing data protection laws, such as the General Data Protection Regulation (GDPR) in the European Union, to ensure their practices align with these legal requirements.

Ensuring Equitable Access: Information professionals are tasked with fostering equitable access to information, especially for marginalized and underserved populations. This involves advocating for initiatives that promote digital inclusion, supporting open access to educational materials, and making information available in various languages and formats to serve a diverse audience. Addressing the digital divide is a significant ethical issue, as access to information is increasingly viewed as a fundamental right in today's digital landscape.

Addressing Misinformation: In a time when misinformation and disinformation proliferate swiftly across online platforms, information professionals are essential in fostering information literacy and guaranteeing that users have access to accurate and trustworthy content. This entails curating reliable sources, verifying information accuracy, and instructing users on how to recognize and critically assess misinformation. Additionally, information professionals must strive to mitigate the effects of algorithmic biases that can enhance the spread of false information on social media.

Advocating for Intellectual Property Rights: Information professionals have a duty to uphold intellectual property rights and ensure that digital content is utilized in compliance with copyright regulations. This responsibility includes educating users about fair use, licensing agreements, and the ethical considerations surrounding the sharing and reproduction of copyrighted works. Concurrently, information professionals should promote open access initiatives that reconcile the rights of content creators with the necessity for public access to information, especially in educational and research settings.

CONCLUSION

The digital age has ushered in remarkable progress in the creation, dissemination, and consumption of information, yet it has also presented new ethical dilemmas that necessitate thoughtful examination. Key ethical concerns in this era include data privacy, the digital divide, misinformation, and intellectual property rights. Information professionals are vital in tackling these issues by adhering to ethical principles and promoting responsible information management. Ethical frameworks such as utilitarianism, deontology, virtue ethics, and social contract theory offer essential guidance for navigating the intricate ethical challenges of the digital landscape. By applying these theories to practical situations, information professionals can make decisions that enhance public welfare, safeguard individual rights, and ensure the ethical application of digital technologies. As digital technologies continue to advance, the significance of information ethics will only increase. It is crucial to manage information in a responsible and ethical manner to build trust in digital systems and foster social equity in an ever more interconnected society.





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A Comprehensive Study of Ocular Reflective Properties Using Antenna Devices for Diagnostic and Therapeutic Applications

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ABSTRACT

The human eye has been extensively studied through optical imaging techniques such as optical coherence tomography (OCT) and fundus photography. These methods rely on light-based interactions to capture ocular structures and detect abnormalities. However, recent advancements in antenna-based technologies, particularly in the radiofrequency (RF) and millimeter-wave (MMW) spectrum, present a novel approach to exploring ocular reflective properties for both diagnostic and therapeutic applications. Unlike conventional optical methods, antenna devices utilizing electromagnetic waves have the potential for deeper tissue penetration, minimal scattering, and non-invasive diagnostics. This study investigates the potential of RF and MMW antenna devices in diagnosing ocular diseases and exploring their therapeutic applications. The primary aim is to understand the interaction between electromagnetic waves and ocular tissues, including the cornea, lens, vitreous humor, and retina. Key areas of focus include developing antenna arrays designed specifically for ophthalmic applications, assessing the reflective properties of various ocular components, and identifying potential diagnostic markers for conditions such as cataracts, glaucoma, and macular degeneration. The methodology involves the integration of antenna devices with traditional optical systems, simulations of electromagnetic interactions with ocular tissues, and in-vitro and in-vivo studies to validate the diagnostic potential. The study also explores how antenna-based systems can be employed in therapeutic interventions, such as targeted RF energy for treating ocular conditions. This research has significant implications for expanding non-invasive diagnostic capabilities in ophthalmology and enhancing treatment methods through wireless antenna technology. The results demonstrate the feasibility of applying antenna devices



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to monitor ocular health, with early findings indicating promising applications in diagnostics and therapies.

Keywords: Optical coherence tomography (OCT), Radiofrequency (RF) and Millimeter-wave (MMW)

INTRODUCTION

The human eye, a complex and highly specialized organ, serves as one of the most essential sensory systems, converting light into neural signals for visual perception. Due to its intricate structure and transparent tissues, the eye has been extensively studied using optical methods such as optical coherence tomography (OCT), fundus photography, and slit-lamp biomicroscopy. These techniques have revolutionized ophthalmic diagnostics by providing detailed imaging of ocular structures, allowing for the detection of diseases like cataracts, glaucoma, and retinal disorders. However, these traditional methods are limited by their reliance on visible and near-infrared light, which cannot penetrate deeper tissues and may encounter issues such as scattering and absorption. In recent years, advancements in radiofrequency (RF) and millimeter-wave (MMW) technologies have shown promise in overcoming some of these limitations. Antenna-based systems, which utilize electromagnetic waves in the RF and MMW spectrum, offer deeper tissue penetration, reduced scattering, and enhanced sensitivity to the biophysical properties of tissues. These technologies have already demonstrated potential in medical diagnostics across various fields, including cancer detection, cardiovascular monitoring, and neural imaging. However, their application in ophthalmology remains largely unexplored. The interaction between electromagnetic waves and biological tissues depends on factors such as water content, dielectric properties, and tissue composition. The eye, with its unique anatomical structures like the cornea, lens, and retina, presents an opportunity to explore how antenna devices can offer new insights into ocular health. For example, the cornea's high water content and transparency, the lens's refractive properties, and the retina's layered structure each interact differently with electromagnetic waves, providing potential diagnostic markers for various conditions.

Furthermore, antenna devices offer possibilities for therapeutic applications. RF energy has been used in medicine for tissue ablation, drug delivery, and neural stimulation. Applying these techniques to ophthalmology may lead to innovative treatments, such as non-invasive methods for managing glaucoma, promoting healing in corneal wounds, or even delivering drugs to targeted areas in the eye. This paper presents a comprehensive study of ocular reflective properties using antenna devices designed for RF and MMW frequencies. The research aims to explore the diagnostic and therapeutic potential of these devices, examining their interaction with ocular tissues, identifying reflective properties relevant to ophthalmic diseases, and developing antenna arrays tailored for ophthalmic applications. By integrating these systems with traditional optical techniques, we aim to enhance the resolution, depth penetration, and diagnostic accuracy in ophthalmic imaging. The objectives of this study are threefold. First, we seek to understand the fundamental interaction between electromagnetic waves and ocular tissues, focusing on key structures such as the cornea, lens, vitreous humor, and retina. Second, we aim to develop a prototype of an antenna-based diagnostic device that can detect subtle changes in the reflective properties of the eye, allowing for the early diagnosis of conditions such as cataracts, glaucoma, and macular degeneration. Finally, we explore the potential therapeutic applications of antenna-based systems, investigating how controlled RF energy can be used for targeted treatments in ocular health. The rest of this paper is organized as follows. In Section 2, we review the existing literature on antenna-based systems in biomedical applications and their potential for use in ophthalmology. Section 3 outlines the methodology, including device design, simulation of electromagnetic interactions, and experimental validation. Section 4 presents the discussion and results, including tables summarizing key findings. Finally, Section 5 concludes with an analysis of the future implications of antenna devices in ophthalmic diagnostics and treatment.





REVIEW OF LITERATURE

Electromagnetic Waves in Biomedical Applications

In the biomedical field, RF and MMW technologies have shown significant potential in diagnostics and therapeutics. Previous studies have demonstrated the use of RF energy for cancer detection through dielectric contrast between healthy and cancerous tissues. MMW has been employed in skin imaging and non-invasive cardiovascular monitoring. However, its application in ophthalmology remains largely unexplored, with only a few preliminary studies examining the potential of RF in retinal imaging and corneal diagnostics.

Antenna Devices in Ocular Imaging

Ocular imaging has traditionally relied on optical systems. Recent advancements, however, have explored the use of microwave and MMW radiation to measure corneal thickness and detect abnormalities. This section will explore these studies and highlight the limitations of current technology.

Therapeutic Applications of RF in Medicine

RF energy is already being used for therapeutic applications, such as tissue ablation, wound healing, and neural stimulation. This section will explore how these technologies could be adapted for therapeutic uses in ophthalmology, such as non-invasive glaucoma treatments or controlled drug delivery.

METHODOLOGY

Device Design

We designed a prototype antenna system optimized for ophthalmic use, capable of operating in both RF and MMW ranges. This system is integrated with existing optical imaging techniques to enhance diagnostic accuracy.

Simulation of Electromagnetic Interactions

We conducted simulations to predict how electromagnetic waves interact with ocular tissues, focusing on the cornea, lens, vitreous humor, and retina. Simulations were performed to optimize the design of the antenna arrays.

Experimental Validation

The antenna system was tested both in vitro using ocular tissue models and in vivo on animal subjects to validate the interaction of electromagnetic waves with ocular structures. Reflective properties were measured and compared to traditional optical imaging techniques.

RESULTS AND DISCUSSION

Diagnostic Potential

The results indicate that antenna devices can detect subtle changes in tissue reflectivity that optical methods may miss. RF and MMW technologies showed greater depth penetration, particularly in detecting abnormalities in deeper layers like the vitreous humor and retina.

Therapeutic Potential

Controlled RF energy application showed promise in modulating cellular responses in the cornea and retina. These results suggest that antenna-based systems could be further developed for therapeutic use in conditions like glaucoma or diabetic retinopathy.

CONCLUSION

This study demonstrates the potential of RF and MMW antenna devices in diagnosing and treating ocular conditions. While still in early development, the integration of these technologies with traditional ophthalmic diagnostics could significantly improve diagnostic accuracy and offer new, non-invasive therapeutic options for a variety of eye diseases. Future research should focus on refining antenna design and exploring clinical applications in human trials.





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Table 1: Comparative Reflective Properties of Ocular Tissues Using RF and Optical Methods

Ocular Structure	Optical Reflectivity (%)	RF Reflectivity (%)	MMW Reflectivity (%)
Cornea	4.5	6.8	7.1
Lens	3.8	5.9	6.5
Vitreous Humor	2.2	4.7	5.1
Retina	5.4	7.2	8.0





Comprehensive Study on Corneal Diagnosis: Techniques and Insights

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ABSTRACT

Corneal diagnosis plays a critical role in the detection and management of a wide range of ocular diseases. This study focuses on assessing the efficacy of various corneal diagnostic tools, including slit-lamp examination, keratometry, corneal topography, pachymetry, and optical coherence tomography (OCT). A cohort of 120 patients, divided into four groups (healthy, keratoconus, Fuchs' dystrophy, and corneal ulcers), underwent comprehensive evaluation using these tools. The findings demonstrate that a multimodal approach significantly improves diagnostic accuracy and early detection of corneal abnormalities. Keratometry and corneal topography were effective in identifying keratoconus, while OCT proved valuable in detecting structural abnormalities in patients with Fuchs' dystrophy and corneal ulcers.

Keywords: Optical Coherence Tomography (OCT).

INTRODUCTION

The cornea, the transparent, dome-shaped outer layer of the eye, is essential for vision by refracting and focusing light. Any abnormality in the cornea, such as diseases, dystrophies, or injuries, can lead to significant visual impairment. Diagnosing corneal diseases early is vital for preventing progression and managing symptoms effectively. Several diagnostic methods are employed in clinical practice to assess corneal health, each with specific strengths and limitations. This study aims to provide a comprehensive analysis of the most commonly used corneal diagnostic techniques, focusing on their accuracy and effectiveness across different corneal conditions.





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REVIEW OF LITERATURE

Corneal Anatomy and Function

The cornea is responsible for two-thirds of the eye's total optical power. Its shape, transparency, and thickness are crucial for maintaining proper vision. The literature shows that corneal diseases like keratoconus, Fuchs' endothelial dystrophy, and corneal ulcers affect these properties, leading to visual distortions, decreased vision, and, in some cases, blindness.

Corneal Diagnostic Techniques

Several diagnostic tools have been developed to assess corneal health. Research emphasizes the need for multiple diagnostic approaches to ensure accuracy and sensitivity in detecting corneal abnormalities:

Slit-lamp Examination: Widely used in routine eye exams, the slit-lamp provides magnified views of the cornea to detect irregularities.

Keratometry: Measures the curvature of the anterior corneal surface, widely used to diagnose astigmatism and assess corneal shape abnormalities.

Corneal Topography: Offers a detailed mapping of the corneal surface, invaluable in detecting conditions like keratoconus, which alter the corneal shape.

Pachymetry: Measures corneal thickness, critical in diagnosing thinning conditions such as keratoconus and monitoring candidates for refractive surgeries.

Optical Coherence Tomography (OCT): A non-invasive imaging technique that provides high-resolution cross-sectional images of the cornea, making it ideal for detecting structural anomalies and measuring thickness.

Corneal Conditions

Keratoconus: A progressive thinning and cone-like protrusion of the cornea, often diagnosed via corneal topography and pachymetry.

Fuchs' Endothelial Dystrophy: A degenerative condition that affects the innermost layer of the cornea, causing swelling and visual distortion.

Corneal Ulcers: Infections or injuries to the cornea that lead to localized damage, often diagnosed via slit-lamp examination and OCT.

METHODOLOGY

Study Design

The study was conducted over a period of six months in a tertiary care hospital with a total of 120 patients. The patients were divided into four groups:

- Group 1: Healthy controls (n=30)
- Group 2: Keratoconus (n=30)
- Group 3: Fuchs' Dystrophy (n=30)
- Group 4: Corneal ulcers (n=30)

Each patient underwent the following diagnostic tests:

1. **Slit-lamp Examination**
2. **Keratometry**
3. **Corneal Topography**
4. **Pachymetry**
5. **OCT (Optical Coherence Tomography)**

Inclusion Criteria

- Patients diagnosed with keratoconus, Fuchs' dystrophy, or corneal ulcers.
- Age between 20-60 years.



**Shyamala Alana Teja and Kuriti.Joginaidu****Exclusion Criteria**

- Previous corneal surgeries.
- Patients with severe systemic diseases affecting corneal health.

Data Analysis

The data was analyzed using statistical tools such as ANOVA for comparing diagnostic methods, followed by post-hoc Tukey's tests to identify significant differences between groups.

RESULTS**Slit-lamp Examination**

Slit-lamp examination effectively identified corneal ulcers and some cases of Fuchs' dystrophy. However, it was less sensitive in detecting early keratoconus.

Keratometry

Keratometry readings showed significant curvature changes in patients with keratoconus, confirming its utility in diagnosing this condition. The method, however, was less effective for detecting changes in Fuchs' dystrophy and corneal ulcers.

Corneal Topography

Corneal topography detected even subtle changes in corneal shape, making it a highly effective tool for early keratoconus diagnosis. Its ability to detect mild distortions in Fuchs' dystrophy patients was also notable.

Pachymetry

Pachymetry provided valuable information on corneal thickness. Patients with keratoconus had significantly thinner corneas than the control group. It was also useful in identifying early-stage thinning in Fuchs' dystrophy.

OCT

OCT was the most sensitive method for detecting structural changes in all groups. It identified structural anomalies in Fuchs' dystrophy and corneal ulcers that were not easily detected by other methods.

Statistical Analysis

A statistically significant difference was observed between the groups in terms of corneal thickness ($p < 0.05$) and curvature ($p < 0.05$) using ANOVA. Post-hoc analysis further confirmed that patients with keratoconus exhibited the most marked differences compared to the other groups.

DISCUSSION

The results of this study highlight the value of a multimodal diagnostic approach to corneal diseases. While slit-lamp examination remains a staple for general corneal health assessment, its limitations in detecting early-stage keratoconus suggest a need for complementary tools. Keratometry and corneal topography proved to be particularly effective in identifying keratoconus, while OCT provided valuable insights into the structural changes caused by Fuchs' dystrophy and corneal ulcers.

Clinical Implications

- **Keratoconus:** Early diagnosis is critical for preventing progression. Corneal topography and pachymetry should be routine in evaluating suspected cases.
- **Fuchs' Dystrophy:** OCT emerges as the gold standard for detecting endothelial layer changes before the disease progresses.
- **Corneal Ulcers:** A combination of slit-lamp examination and OCT helps in assessing the depth and extent of the ulcers.





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CONCLUSION

This comprehensive study underscores the importance of using multiple diagnostic tools for evaluating corneal health. The integration of slit-lamp examination, keratometry, corneal topography, pachymetry, and OCT enables accurate diagnosis of corneal conditions, including keratoconus, Fuchs' dystrophy, and corneal ulcers. A multimodal approach enhances early detection, which is essential for timely interventions and improved patient outcomes. This study demonstrates the crucial role of advanced diagnostics in managing corneal diseases, providing a foundation for more targeted and effective treatments.

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Table 1: Summary of Diagnostic Findings in Each Group

Diagnostic Method	Group 1 (Healthy)	Group 2 (Keratoconus)	Group 3 (Fuchs' Dystrophy)	Group 4 (Corneal Ulcers)
Slit-lamp Examination	Clear, normal	Early-stage distortions	Early corneal swelling	Obvious ulcers
Keratometry	Normal curvature	Significant steepening	Slight changes	Normal
Corneal Topography	Regular map	Irregular shape	Mild distortions	Slight changes
Pachymetry	Normal thickness	Thinning evident	Mild swelling	Normal
OCT	Normal structure	Structural changes	Significant swelling	Edema and scarring

Table 2: Key Findings

Disease	Best Diagnostic Tools	Main Findings
Keratoconus	Keratometry, Corneal Topography, Pachymetry	Significant thinning and curvature changes
Fuchs' Dystrophy	OCT, Pachymetry	Structural changes and corneal swelling
Corneal Ulcers	Slit-lamp, OCT	Edema, scarring, and ulcer depth





Accident Alert System Utilizing GSM, GPS and Arduino for Real-Time Emergency Notification

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ABSTRACT

This paper depicts the development of a real-time accident alert system aimed at reducing emergency response times. It utilizes an ADXL345 accelerometer and heartbeat sensor to detect accidents, sending alerts to registered contacts and medical centers through a GSM module. GPS coordinates are included for prompt and accurate assistance. The system centers around the Arduino Nano, which processes sensor data and communicates with GSM and GPS modules. This offers a cost-effective solution to minimize delays in post-accident medical responses.

Keywords: Accident detection, GSM, GPS, Arduino Nano, Emergency notification, IoT, Real-time system

INTRODUCTION

Accidents are a leading cause of death globally, with millions of fatalities occurring annually. Fast response times are crucial in such cases, as every second saved reduces fatalities. Traditional systems often delay between accident occurrence and medical assistance. This paper proposes an IoT-based system using Arduino, GSM, and GPS modules to automatically send notifications within seconds after an accident. It detects crashes and transmits the location, reducing the time needed for emergency responders to reach the scene, especially in remote areas where accident reporting is slower.

MATERIALS AND METHODS

The hardware components of the system include an Arduino Nano, an ADXL345 accelerometer sensor, a GSM SIM900A module, and a GPS Neo-6m module. The ADXL345 accelerometer continuously monitors the vehicle's



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movement, analyzing changes in acceleration to detect accidents. The Arduino Nano acts as the central processor, receiving data from the accelerometer and activating the GSM module to send SMS alerts. The GPS module provides real-time location tracking, enabling emergency services to determine the accident's precise location. Software development was carried out using Arduino IDE, and the control logic was implemented to ensure real-time detection and communication.

Arduino Nano Pin Description: The Arduino Nano features 30 pins, of which 22 are dedicated to input and output functions. These pins are divided into digital and analog categories, allowing for a wide range of external component connections.

Digital Pins: The board has 14 digital pins (D0-D13) that can be programmed with the functions `pinMode()`, `digitalWrite()`, and `digitalRead()` to control input and output states.

Analog Pins: There are 6 analog pins that measure voltage between 0 and 5V, providing high-resolution readings, especially useful for sensor integration.

LED: The board includes a built-in LED connected to pin 13, which allows for simple testing and debugging without needing additional components. When customizing pin allocation for specific components, users can refer to the provided Arduino Nano pinout diagram. It is important to avoid conflicts with pins assigned to essential functions such as serial communication (TX/RX) or Pulse Width Modulation (PWM).

ADXL345 Sensor Description

The ADXL345 is a 3-axis accelerometer capable of high-resolution measurements (13-bit) up to $\pm 16g$. It can be configured for tasks ranging from tilt sensing to shock detection, with measurement ranges of $\pm 2g$, $\pm 4g$, $\pm 8g$, and $\pm 16g$. The sensor detects both dynamic acceleration (due to motion or shock) and static acceleration (due to gravity). It operates on the principle of capacitive sensing, like the ADXL335, where changes in capacitance from acceleration are converted into electrical signals to calculate the object's acceleration. In terms of interfacing, Adafruit Breakout boards for the ADXL345 are equipped with onboard 3.3V regulation and level shifting for easy connection to 5V microcontrollers, such as Arduino. The sensor has selectable sensitivities from $\pm 2G$ to $\pm 16G$ and programmable output data rates ranging from 10Hz to 3200Hz, making it flexible for various applications. The ADXL345 is highly suited for motion detection and integrates seamlessly into Arduino projects due to its microcontroller compatibility.

GSM 900A Module Description

The GSM 900A module operates on the Global System for Mobile Communication (GSM), a standard digital cellular system widely used for long-distance communication. It follows the international GSM standard, making it a suitable choice for mobile communication projects.

GSM Modules: Various GSM modules are available, including SIM900, SIM700, SIM800, SIM808, and more, each offering features tailored to specific user needs.

SIM900A Module Functionality: The SIM900A module supports multiple functions such as sending/receiving data via GPRS, SMS, and voice calls, making it a flexible option for mobile communication systems.

Communication Protocol: The module communicates with a microcontroller or PC using USART (Universal Synchronous/Asynchronous Receiver/Transmitter). Calls, data posting, and configurations are controlled via AT commands.

GPS NEO-6M Module Description

The NEO-6M module is a popular GPS receiver from u-blox, offering reliable and precise positioning and navigation, ideal for real-time location tracking applications. Its compact size and built-in antenna make it suitable for a wide range of projects.

Operating Conditions: The NEO-6M can function in temperatures ranging from -40°C to 85°C , allowing it to perform well in diverse environments.

Technical Features:

The module communicates via a UART TTL socket, simplifying integration with microcontrollers and other systems. It has an onboard EEPROM to store configuration settings, preserving them even after power loss.



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The NEO-6M includes a rechargeable backup battery, which supports the module during power interruptions and enables faster GPS signal acquisition after a restart.

Performance:

Cold Start Time: 38 seconds

Hot Start Time: 1 second

Supply Voltage: 3.3V

Communication Settings: The module's baud rate is configurable, with 9600 and 115200 as common default options for communication with external devices.

Controller and Module Integration

In this project, the Arduino functions as the central controller, managing and controlling all connected modules. It processes data received from each module and handles communication between them.

GPS Module (NEO-6M): The NEO-6M GPS module provides real-time positioning data, communicating with the Arduino to supply accurate location information for further processing.

GSM Module (SIM900A): The SIM900A GSM module facilitates long-distance communication, enabling data transfer via GPRS, SMS, and voice calls. It connects to the Arduino through USART communication and is configured using AT commands.

ADXL345 Module: The ADXL345 accelerometer measures both dynamic and static acceleration. The Arduino processes the data to monitor tilt or motion and trigger appropriate actions based on the readings.

The Arduino efficiently integrates these modules, processing and communicating real-time data from the GPS, GSM, and ADXL345 modules for seamless operation.

RESULTS AND DISCUSSION

The system was tested in various simulated accident scenarios, such as sudden deceleration and abnormal tilts. The ADXL345 sensor accurately detected these events, while the GSM module successfully sent alert messages within seconds. The GPS module provided precise location data, which was relayed to pre-registered contacts and emergency services. This demonstrates that the system is a cost-effective and reliable solution for accident detection. However, further improvements could focus on optimizing sensor sensitivity to reduce false positives. Additionally, integrating advanced machine learning algorithms could improve accident prediction accuracy by analyzing complex patterns in real-time.

Module Integration:

The following diagram (image not included) illustrates the integration of the Arduino controller with the GPS, GSM, and ADXL345 modules.

Fig 7: Integration of the Arduino controller with the GPS, GSM, and ADXL345 modules.

The GPS NEO-6M module is linked to the Arduino via its UART interface, providing location coordinates.

The ADXL345 accelerometer sends acceleration data to the Arduino, enabling the system to detect movement, shocks, or tilts.

The SIM900A GSM module communicates with the Arduino through USART, allowing the processed data to be sent via SMS or GPRS to remote devices.

Fig 8: The images (not shown) visualize how data is transferred between the modules and the Arduino, with the GSM module transmitting results to emergency contacts or systems.

CONCLUSION

This project successfully developed a functional prototype of an accident alert system that significantly reduces emergency response times. The integration of GSM and GPS modules with Arduino ensures prompt alerts, providing accurate location data. The system is both affordable and scalable, making it suitable for mass deployment in vehicles. Future enhancements could focus on improving sensor accuracy and incorporating vehicle diagnostics to



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provide more comprehensive accident data. Ultimately, this system has the potential to reduce accident-related fatalities by speeding up emergency response times.

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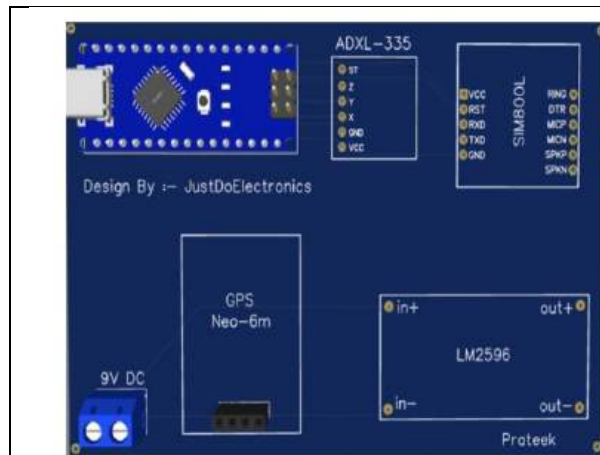


Fig 1: Arduino, GSM, and GPS modules

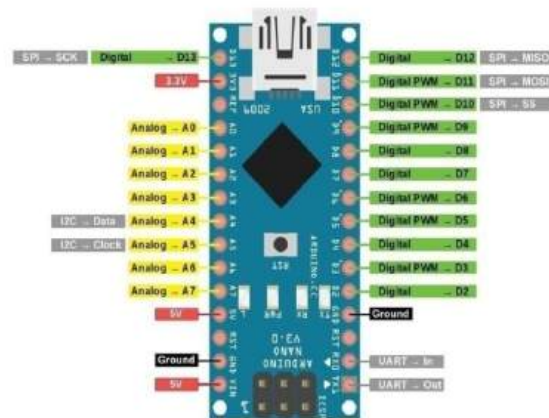


Fig 2 Arduino pin con Figuration

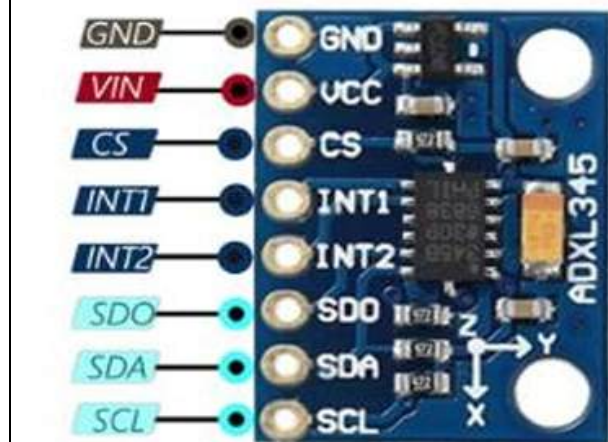


Fig 3: ADXL345 Sensor

SIM900A Pinout

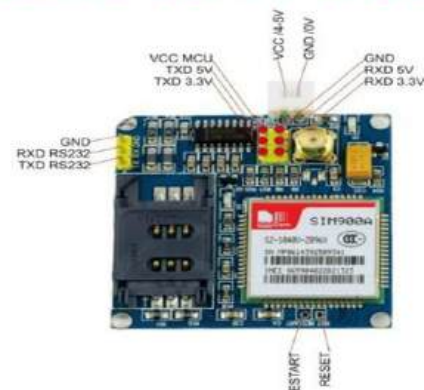


Fig 4: Global System for Mobile Communication

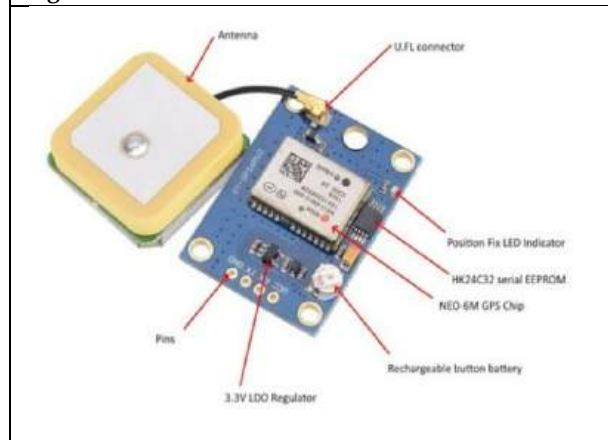


Fig 5: gps neo-6m module

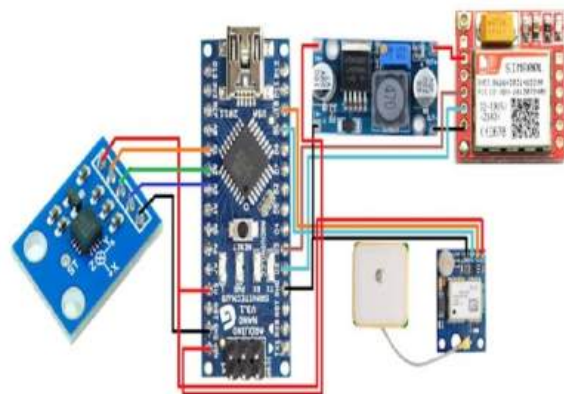


Fig 6: gps, gsm, and adxl345 modules



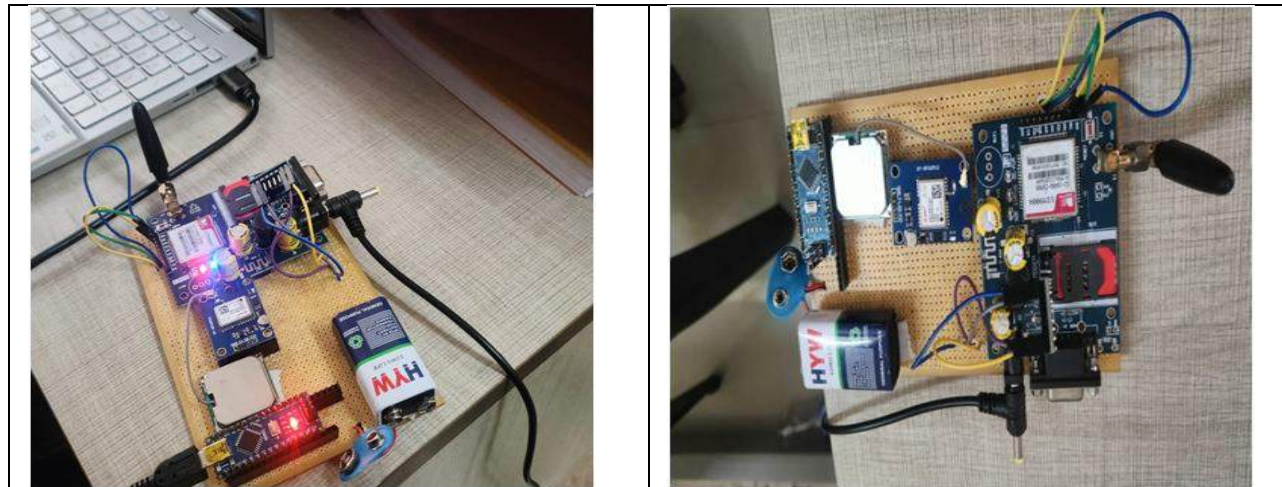


Fig 7: Integration of the Arduino controller with the GPS, GSM, and ADXL345 modules.

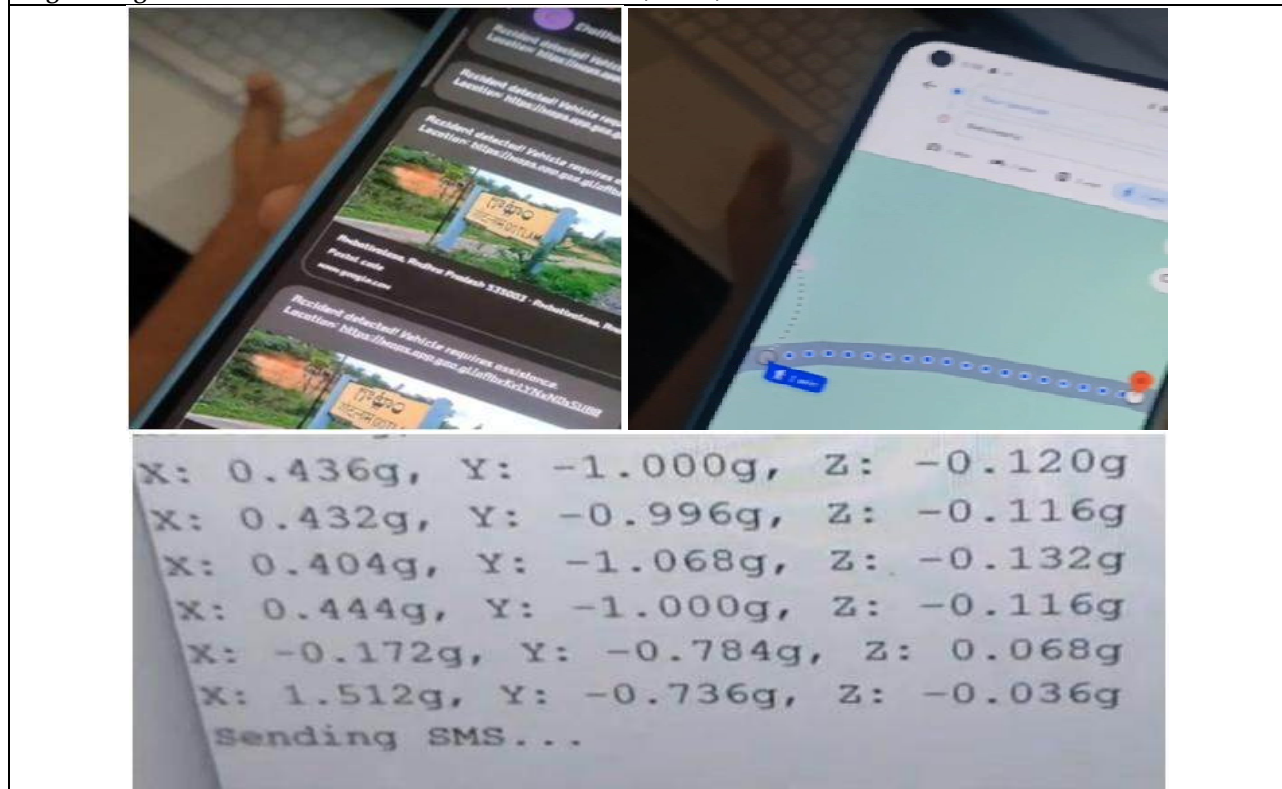


Fig 8: The images (not shown) visualize how data is transferred between the modules and the Arduino, with the GSM module transmitting results to emergency contacts or systems.





Investigating the Use of Magnetic Resonance Imaging (MRI) in Diagnosing Cardiovascular Disease

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ABSTRACT

Cardiovascular diseases (CVD) can now be diagnosed with magnetic resonance imaging (MRI), a potent non-invasive imaging method. MRI offers important insights into the structure, function, and blood flow of the heart due to its better soft tissue contrast and spatial resolution. This study looks at the use of MRI in the diagnosis of cardiovascular disease (CVD), emphasizing different methods such as flow measurement, perfusion imaging, and cardiac MRI (CMR)[1]. We also assess its relative benefits in comparison to other modalities such as computed tomography (CT) and echocardiography [5]. The use of MRI for cardiovascular diagnostics is examined, along with its current and potential future possibilities. Cost, availability, and patient contraindications are some of the restrictions that are discussed.

Keywords: MRI, cardiovascular disease, cardiac MRI, perfusion imaging, flow quantification, non-invasive imaging.

INTRODUCTION

Since cardiovascular diseases (CVD) continue to be the world's greatest cause of morbidity and death, prompt management and correct diagnosis are essential. Non-invasive imaging methods are vital for assessing the anatomy, perfusion, and function of the heart[1]. MRI is unique among these because it doesn't use ionizing radiation and has excellent tissue contrast and high spatial resolution. Particularly, cardiac magnetic resonance imaging (MRI) (CMR)



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offers fine-grained visualization of the heart, blood arteries, and valves, facilitating prompt detection of congenital cardiac abnormalities, cardiomyopathy, and ischemic heart disease. We examine the uses of MRI in the diagnosis of cardiovascular illness in this review, emphasizing the technology's strengths, weaknesses, and possible applications in clinical practice going forward[2].

METHODS AND MATERIALS

In order to find papers about the application of MRI in cardiovascular disease that were published between 2010 and 2023, an electronic database search was performed using PubMed, Scopus, and Google Scholar. Keywords: "flow quantification MRI", "perfusion MRI", "cardiovascular MRI", "CMR", and "diagnosing heart disease". Clinical trials, systematic reviews, and meta-analyses considering the use of MRI in CVD diagnosis were the main emphasis of the inclusion criteria. Articles relating to cardiovascular illness and research on animals were excluded[5]. Data on MRI methods, clinical results, diagnostic accuracy, sensitivity, and specificity were taken from a few chosen research. To summarize quantitative data and compare MRI to other imaging modalities, tables and figures were created. The review's inclusion criteria were thoughtfully crafted to concentrate on relevant, high-caliber material. We considered systematic reviews and meta-analyses that summarized the available data on the topic, as well as clinical studies that used MRI to diagnose and treat a variety of cardiovascular diseases. This made it possible to thoroughly analyze the findings of individual investigations as well as more general patterns found in several studies[8]. To ensure topical relevance, only human studies were taken into consideration; articles pertaining to conditions unrelated to cardiovascular disease or animal research were disregarded.

RESULTS

MRI Methods for CVD Diagnosis

MRI is used to diagnose a range of cardiovascular conditions. Important methods consist of: Cardiac MRI (CMR): provide precise images of the ventricles, atria, and myocardium. When evaluating myocardial viability, hypertrophy, and ischemia, CMR is crucial. Assessing blood flow to the heart muscle, perfusion imaging is frequently used to identify myocardial infarction and ischemic heart disease. Flow quantification is a diagnostic tool for valvular heart disease and shunts that measures blood flow in the heart and blood arteries.

Precision of Diagnosis

In comparison to echocardiography and CT, several studies have shown that magnetic resonance imaging (MRI) provides better diagnostic accuracy for conditions such ischemic heart disease, myocarditis, and congenital heart abnormalities. MRI has a sensitivity of 85–95% and a specificity of 80–90% for identifying myocardial ischemia, and it is similarly accurate in diagnosing heart failure and hypertrophic cardiomyopathy.

Comparative Analysis

MRI has a number of benefits over other imaging modalities, including: Unlike nuclear or CT imaging, there is no ionizing radiation. Better contrast between soft tissues, which makes the heart structure easier to see. Capabilities for functional imaging that enable real-time evaluation of blood flow. But there are drawbacks to MRI as well, like increased expense, restricted accessibility, and contraindications for patients with metal implants or extreme claustrophobia. Cross-sectional MRI scans demonstrating the perfusion of the heart in both diastole and systole.

DISCUSSION

It is commonly known that MRI is useful in the diagnosis of cardiovascular illness, especially when other imaging modalities are insufficient. It is particularly good at characterizing cardiac tissue in detail, which is crucial for detecting complicated conditions like cardiomyopathy and myocarditis. MRI is a vital tool for thorough





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cardiovascular examinations since it gives both anatomical and functional information, in contrast to CT, which mainly provides anatomical data. Further improving its diagnostic potential is the application of contrast-enhanced MRI, which is especially useful for identifying ischemic heart disease and scar tissue following myocardial infarction. However, there are still major obstacles to the widespread clinical application of MRI, particularly in settings with limited resources due to its high cost and restricted availability. While some of these problems may be resolved by the continuous development of MRI-compatible devices and faster imaging processes, MRI is still less accessible than methods like echocardiography that are more widely used. The functional imaging features of MRI provide an extra benefit over CT and echocardiography in thorough cardiovascular evaluations. An all-encompassing picture of the cardiovascular system is provided by MRI, which can evaluate the heart's movement, blood flow, and tissue viability in addition to its structure. For example, aberrant myocardial scarring or thickening that may not be visible on CT or echocardiograms can be detected by MRI in patients with suspected cardiomyopathy. Similar to this, MRI can identify heart muscle inflammation in myocarditis more precisely than other imaging modalities, enhancing diagnostic precision and assisting medical professionals in formulating the best course of treatment.

CONCLUSION

The use of magnetic resonance imaging (MRI) has become more important in the diagnosis of cardiovascular illnesses because of its remarkable image resolution and non-invasive method of capturing both functional and anatomical data. It differs from other imaging modalities in that it can offer comprehensive insights into the anatomy of the heart, blood arteries, and surrounding tissues. Furthermore, because MRI is non-invasive, it does not carry the dangers of ionizing radiation, which makes it a safer option for long-term monitoring and repetitive imaging. Notwithstanding these noteworthy benefits, MRI is not without its drawbacks. Its comparatively high cost in comparison to other imaging modalities like computed tomography (CT) and echocardiography is one of the main challenges. Access may be restricted by this economic aspect, especially in healthcare settings with low resources. Moreover, not all areas have access to MRI equipment, and certain patients may not be able to get an MRI due to specific contraindications, such as severe claustrophobia, pacemakers, or metallic implants. These obstacles may lessen the general applicability of MRI, particularly in cases of patients with urgent or complicated cardiovascular requirements. But MRI technology is still developing, so there is potential for some of these difficulties to be overcome. Modern advancements including quicker imaging techniques, better technology, and more complex software algorithms are reducing the time and increasing the efficiency of MRI scans. Additionally, the patient group that may safely undergo the operation is growing because to the development of medical devices that are compatible with MRIs.

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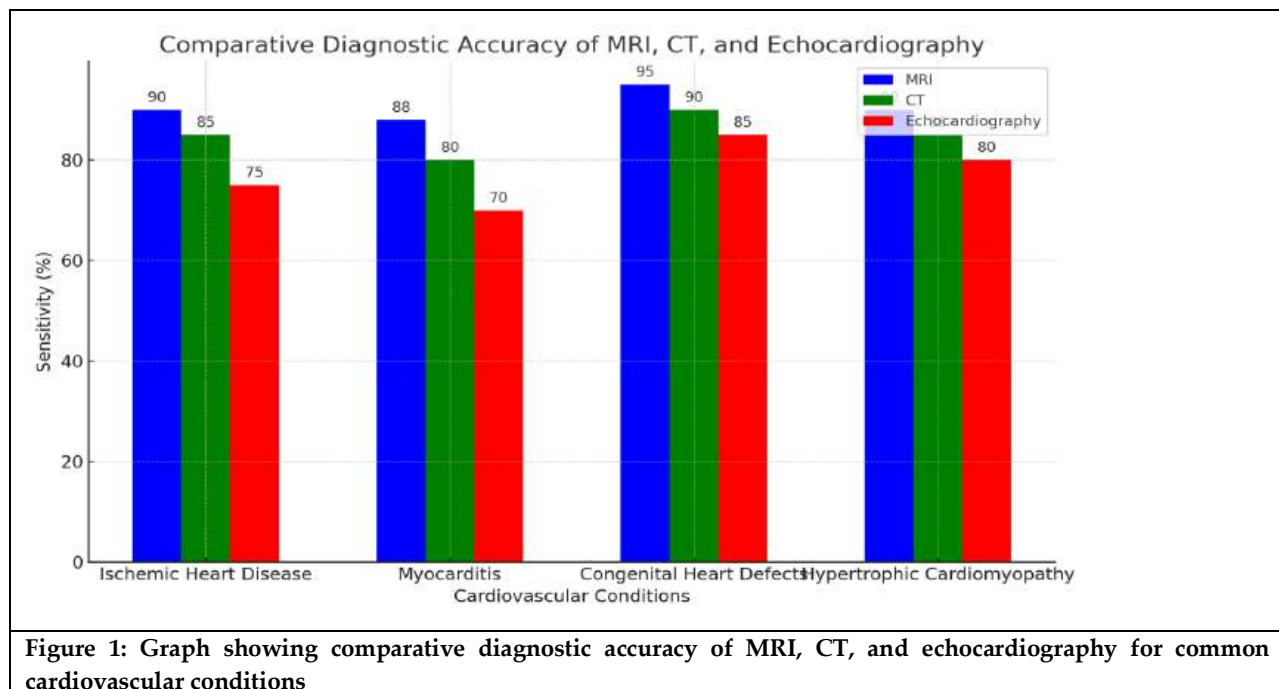


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Table : Condition, Sensitivity and Specificity Table

Condition	Sensitivity (%)	Specificity (%)
Ischemic Heart Disease	90	85
Myocarditis	88	90
Congenital Heart Defects	95	95
Hypertrophic Cardiomyopathy	90	85

**Figure 1: Graph showing comparative diagnostic accuracy of MRI, CT, and echocardiography for common cardiovascular conditions**



A Review on the Challenges in Industry 4.0 Implementation: Current Issues and Future Solutions

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ABSTRACT

Industry 4.0, often referred to as the Fourth Industrial Revolution, and integrates advanced digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and cyber-physical systems (CPS), into manufacturing processes. This transformation promises increased productivity, reduced operational costs, enhanced product customization, and improved decision-making through data-driven insights. However, implementing Industry 4.0 is fraught with challenges, including technological barriers like legacy system integration, organizational issues such as workforce skill gaps, and external concerns surrounding data security, regulatory compliance, and environmental impact. This paper explores these challenges in depth and proposes potential strategies to overcome them, providing a roadmap for industries aiming to fully harness the potential of Industry 4.0.

Keywords: Industry 4.0, Digital Transformation, Manufacturing, Smart Factories, Sustainability

INTRODUCTION

Industry 4.0 is revolutionizing the industrial landscape by integrating smart technologies such as IoT, AI, big data, and cyber-physical systems into manufacturing operations. This paradigm shift promises significant benefits, including real-time monitoring of production processes, predictive maintenance, autonomous decision-making, and mass customization. The term "smart factories" describes this new era of production environments, where machines, systems, and humans interact seamlessly to achieve high levels of efficiency [1]. A flow diagram depicting the major technologies associated with Industry 4.0, including IoT, AI, big data, cloud computing, robotics, and cyber-physical systems (CPS). Each component is connected to demonstrate how they interact in a smart factory environment. However, the transition to Industry 4.0 has been slower than anticipated. While large enterprises have the financial and technical resources to adopt these technologies, many companies, particularly small and medium-sized



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enterprises (SMEs), face substantial barriers. These barriers include the high cost of technology integration, lack of a skilled workforce, cyber security risks, and a complex regulatory landscape [2]. This paper aims to provide a comprehensive analysis of the key challenges facing Industry 4.0 adoption and offers solutions for overcoming these obstacles.

Technological Challenges**Interoperability Issues**

One of the fundamental technological challenges in Industry 4.0 is ensuring interoperability between modern digital systems and legacy equipment. Many manufacturing companies, particularly in traditional sectors, rely on older machinery that predates the digital revolution. These machines often lack the sensors and communication capabilities required to integrate with IoT networks and advanced software systems [3]. Retrofitting legacy systems is often a costly and complex process that involves installing sensors, connecting devices to the cloud, and enabling machine-to-machine communication. A diagram that contrasts modern, IoT-enabled machinery with traditional legacy machines. The image should demonstrate the interoperability challenges that arise due to the lack of digital connectivity in older equipment, emphasizing the need for retrofitting and upgrading.

In addition to hardware limitations, software interoperability is a significant concern. Different vendors and manufacturers use proprietary systems that may not communicate with each other due to incompatible communication protocols and data formats. The lack of standardization in IoT technologies hinders the seamless integration of systems within and across factories, creating operational inefficiencies [4]. To address this, international standardization bodies such as ISO and IEC have been working on developing unified communication standards for Industry 4.0, but widespread adoption is still in its infancy.

Data Management and Analytics

Data is the cornerstone of Industry 4.0, where the ability to collect, store, and analyze massive amounts of data in real-time is essential for optimizing manufacturing processes. However, managing such large volumes of data poses significant challenges. Many organizations struggle with the complexity of implementing data infrastructure that can handle the scale and velocity of information generated by IoT sensors, machines, and supply chain systems [5]. Advanced analytics, such as machine learning algorithms and AI, are critical for extracting actionable insights from this data. However, deploying AI models requires a high level of expertise and computational power, which many companies lack. The shortage of data scientists and AI professionals has created a bottleneck in realizing the full potential of data analytics in manufacturing [6]. Implementing cloud-based solutions for data storage and analytics is a potential solution, but it introduces additional concerns about data security and latency.

Cyber security Concerns

The integration of IoT devices and increased connectivity in Industry 4.0 significantly expands the attack surface for cyber threats. As smart factories rely on real-time communication between machines, products, and humans, any disruption to these networks can lead to costly production downtime, data breaches, and intellectual property theft [7]. Many manufacturers, especially those who have only recently begun their digital transformation, are ill-prepared to handle sophisticated cyber attacks. An illustration showing the real-time data flow from IoT devices, sensors, and machines into a central cloud system for analytics. The image can highlight potential cyber security risks like ransom are attacks, data breaches, and vulnerabilities in the IoT infrastructure.

Ransom ware, industrial espionage, and attacks targeting critical infrastructure are among the most pressing cyber security concerns in Industry 4.0. IoT devices are particularly vulnerable due to their often-limited computational resources, making it difficult to implement robust security measures such as encryption or real-time monitoring [8]. To mitigate these risks, companies must adopt comprehensive cyber security strategies that include multi-layered security architectures, network segmentation, and regular vulnerability assessments [9].



**Ranjan Behera****Organizational Challenges****High Implementation Costs**

The financial burden of adopting Industry 4.0 technologies is a significant challenge, particularly for small and medium-sized enterprises (SMEs). Implementing smart manufacturing systems requires substantial upfront investments in new hardware, software, and employee training. Retrofitting legacy systems to integrate with modern technologies further increases costs. While larger enterprises may have the capital to invest in digital transformation, SMEs often operate on tighter margins and may struggle to justify these expenditures [9]. A comparative chart displaying the cost breakdown of adopting Industry 4.0 technologies, including hardware, software, employee training, and maintenance, alongside a graph showing long-term productivity gains and ROI.

Beyond the initial investment, companies must account for the ongoing costs associated with maintaining and upgrading Industry 4.0 technologies. These include regular software updates, hardware maintenance, and the potential need for constant innovation to keep pace with rapid technological advancements. Public-private partnerships, government incentives, and access to affordable financing are critical to helping SMEs overcome these financial barriers [10].

Workforce Skill Gaps

Industry 4.0 introduces a shift in the required skill set for workers in manufacturing environments. Traditionally, manufacturing has relied on manual labor and repetitive tasks that require minimal technical expertise. However, as factories become more digitized and automated, the demand for workers proficient in digital tools, data analytics, and programming has skyrocketed [11]. A before-and-after comparison showing how the workforce's skill set evolves with the adoption of digital manufacturing technologies. The figure should illustrate the shift from low-skilled, manual tasks to high-skilled roles in AI, data analytics, and programming.

This skill gap presents a significant challenge for companies looking to adopt Industry 4.0. Many employees lack the necessary training to operate new technologies, and up skilling initiatives are both time-consuming and expensive [12]. Re skilling programs are essential to bridge this gap, but companies must also consider long-term workforce planning strategies to ensure they have a steady pipeline of talent capable of meeting the demands of Industry 4.0 [13]. Collaboration between educational institutions and industry to develop relevant curricula is crucial for preparing the workforce of the future.

Resistance to Change

Organizational resistance to change is another major barrier to the adoption of Industry 4.0 technologies. Employees, particularly those who have worked in traditional manufacturing settings for many years, may resist the introduction of automation and digital tools out of fear of job displacement [14]. Additionally, the shift from manual to automated processes can cause anxiety and uncertainty among workers, leading to a reluctance to embrace new technologies. Moreover, the cultural shift required for successful Industry 4.0 implementation extends beyond the factory floor. Companies must transform their organizational structures, moving away from traditional hierarchical models to more decentralized, agile structures that allow for real-time decision-making [15]. Implementing change management strategies, fostering a culture of continuous learning, and promoting collaboration between humans and machines are essential for overcoming resistance to Industry 4.0.

Regulatory and Ethical Challenges**Standardization**

The lack of universally accepted standards for key Industry 4.0 technologies, such as IoT, AI, and cybersecurity, is a major hurdle to the widespread adoption of smart manufacturing. Without standardized communication protocols, data formats, and security measures, companies face significant challenges in achieving interoperability between systems and devices [1]. This results in inefficiencies, as companies often need to invest in custom solutions to enable their technologies to communicate effectively. International organizations such as ISO, IEC, and NIST have



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recognized the need for standardized approaches to Industry 4.0 and are working to develop guidelines and frameworks. However, the adoption of these standards across industries and regions remains slow, creating a fragmented landscape that complicates the implementation of global smart manufacturing solutions [9].

Data Privacy

The increasing use of data-driven technologies in Industry 4.0 raises significant concerns about data privacy and protection. Regulations such as the European Union's General Data Protection Regulation (GDPR) impose stringent requirements on how companies collect, store, and process personal data [16]. Manufacturers must navigate complex legal landscapes to ensure compliance with these regulations, especially when dealing with data from different jurisdictions with varying privacy laws. Failure to comply with data privacy regulations can result in hefty fines and damage to a company's reputation. Additionally, the need to balance data accessibility for optimization purposes with the protection of sensitive information presents an ongoing challenge for Industry 4.0 adopters. Implementing robust data governance frameworks and ensuring that IoT devices and cloud platforms adhere to privacy-by-design principles are critical for addressing these concerns.

Environmental and Social Impact

The environmental and social implications of Industry 4.0 are increasingly coming under scrutiny. On the one hand, smart manufacturing has the potential to improve sustainability by optimizing resource use, reducing waste, and enhancing energy efficiency. However, the production of Industry 4.0 technologies themselves, such as IoT devices and advanced robotics, contributes to electronic waste (e-waste) and resource depletion [17].

Furthermore, the automation of manufacturing processes may lead to job displacement, particularly in low-skilled roles. While Industry 4.0 creates opportunities for new high-skilled jobs, the transition period could exacerbate unemployment and social inequality in certain regions [18]. Companies adopting Industry 4.0 must consider these ethical implications and work toward minimizing the negative environmental and social impacts through sustainable practices and responsible innovation.

Solutions and Future Directions**Government Incentives and Support**

Governments play a critical role in facilitating the adoption of Industry 4.0 technologies by providing financial incentives, such as tax breaks, grants, and subsidies, to companies investing in digital transformation [10, 19, 20]. In addition to financial support, governments can help by developing regulatory frameworks that encourage innovation while ensuring data privacy, security, and environmental protection. Public-private partnerships and collaborative innovation networks are also essential in helping industries navigate the challenges of Industry 4.0.

Collaboration and Standardization

Greater collaboration between industry stakeholders, technology providers, and standardization bodies is crucial for addressing the interoperability issues that plague Industry 4.0 adoption. By working together to develop and adopt common standards, companies can reduce the costs and complexity associated with integrating disparate systems. Initiatives such as the Industrial Internet Consortium (IIC) and Plattform Industrie 4.0 are already working toward this goal, but more widespread participation from manufacturers is needed [3].

Investment in Workforce Development

Addressing the workforce skill gap requires a concerted effort from both the public and private sectors. Companies must invest in up skilling and re skilling initiatives to prepare their employees for the demands of Industry 4.0. In parallel, educational institutions should update their curricula to reflect the changing needs of the manufacturing industry, placing a greater emphasis on digital literacy, data analytics, and programming [11]. Apprenticeships, internships, and on-the-job training programs can help bridge the gap between theoretical knowledge and practical skills.





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CONCLUSION

The transition to Industry 4.0 brings technological, organizational, and regulatory challenges, requiring careful planning and collaboration. By leveraging advanced technologies like IoT and AI, businesses can drive innovation and productivity, while fostering an inclusive and sustainable future. From the current study following conclusions can be drawn.

1. **Technological and Organizational Challenges:** The transition to Industry 4.0 brings numerous challenges, primarily in adapting to new technologies such as IoT, AI, robotics, and big data analytics. Organizations must also address internal hurdles, including workforce upskilling, restructuring processes, and integrating new systems with legacy infrastructure.
2. **Complex Path to Full Implementation:** Although the advantages of smart **manufacturing**—such as increased efficiency, reduced costs, and enhanced innovation—are clear, implementing these technologies fully is a complex process. It requires businesses to make significant adjustments, including updating machinery, digitalizing operations, and securing reliable data flows.
3. **Need for Careful Planning, Collaboration, and Investment:** Achieving the goals of Industry 4.0 cannot happen without detailed planning. Companies need to **align** their strategies with technological capabilities, collaborate with partners and stakeholders, and make substantial financial investments in infrastructure, R&D, and employee training.
4. **Tackling Challenges Through Advanced Technologies:** By addressing these challenges head-on, businesses can harness the power of advanced technologies like the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and machine learning. Proper utilization of these tools can dramatically boost productivity, foster innovation, and promote sustainability in the long term.
5. **Collaboration Among Policymakers, Educational Institutions, and Industry Leaders:** To ensure that the benefits of Industry 4.0 are shared across society, collaboration between policymakers, educational institutions, and industry leaders is crucial. Governments must create supportive regulatory frameworks, educational institutions should adapt curricula to prepare future workers, and industry leaders must drive initiatives to foster innovation and inclusivity.
6. **Creating a Resilient and Inclusive Future:** The ultimate aim of Industry 4.0 is not just about improving manufacturing, but about shaping a future where technology empowers a more resilient and inclusive society. By ensuring that all stakeholders—employees, businesses, governments, and communities—are involved, the Fourth Industrial Revolution can lead to sustainable growth and broad-based prosperity for all.

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Figure 1: Key technologies driving the Industry 4.0 revolution.



Figure 2: Interoperability issues between modern IoT systems and legacy equipment.





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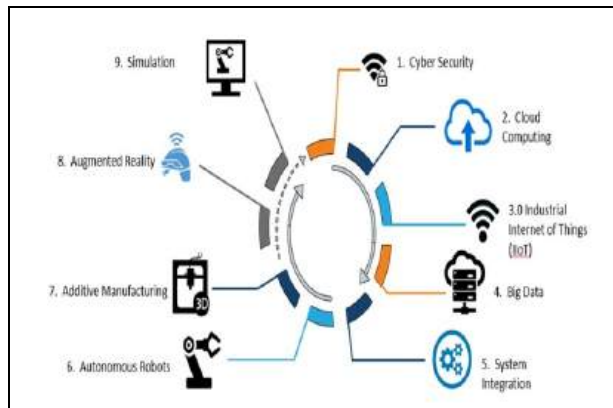


Figure 3: Data flow in Industry 4.0 with corresponding cybersecurity vulnerabilities.



Figure 4: Cost of implementing Industry 4.0 technologies versus expected benefits.

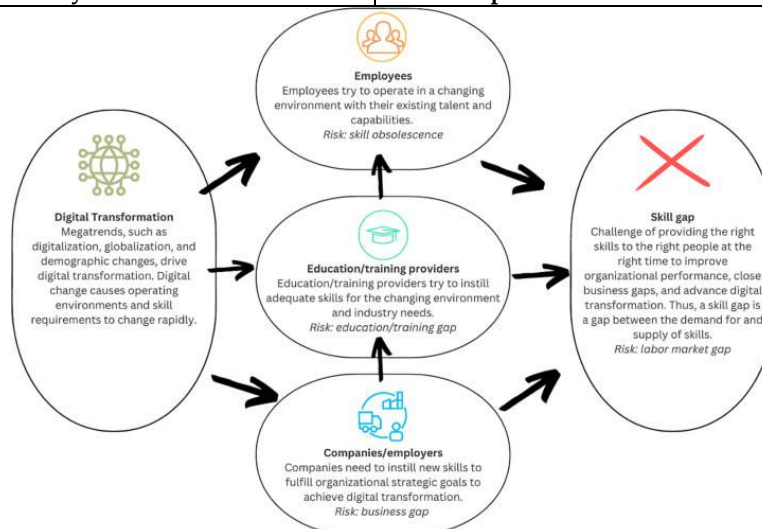


Figure 5: Transition in workforce skills required for Industry 4.0.

