**RESEARCH ARTICLE**

# A Comparative Analysis of the Processes of Formation of Selected Farmer Producer Companies – A Case Study

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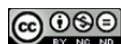
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**ABSTRACT**

The present study was conducted to analyse the processes of formation of Farmer Producer Companies (FPCs). Three Farmer Producer Companies, namely, Ramnad Pesticide Free Chillies Producer Company, Ayakudi Guava and Fruits Producer Company and Dharmapuri District Minor Millets Producer Company facilitated by a Non Governmental Organisation, State Agricultural University and line department of Agricultural Marketing respectively were selected. Focused Group Discussions were conducted during March to May, 2015, involving a total number of 71 Directors and Members and the processes were identified. It was found that the major processes that led to the formation of FPCs were creating awareness, building confidence, convincing, capacity building for collective production, processing, value addition and marketing, conducting trainings, demonstrations, exposure visits, Buyer-Seller Meets and Stakeholders' Meets. The catalyst agency has, therefore, to use an appropriate combination of such processes for facilitating the formation of FPCs.

**Key words:** FPO, Non Governmental Organisation, capacity building.

## INTRODUCTION

The Farmer Producer Company (FPC) serves as a platform for the farmers to get organized as a functional entity for collective production of quality farm produces, processing and value addition and direct marketing. In 2013, Small Farmers Agribusiness Consortium (SFAC) was identified by the Government of India as a nodal agency for

promotion of Farmer Producer Organisations (FPOs) in India. The mission of the SFAC is to provide the required assistance and resources – policy action, inputs, technical knowledge, financial resources and infrastructure to strengthen the FPOs.

It is an established fact that small producers require an external catalyst to bring them together in an FPO and to build their capacities to govern the institutions in a self-sustaining manner (NAC, 2013). The producer organizations (POs) are formal rural organizations whose members organized themselves with the objective of improving farm income through improved production, marketing, and local processing activities. (Rondot and Collion, 2001).

Ever since Companies Act was amended to establish FPCs, Non-Governmental Organisations (NGOs), State Agricultural Universities (SAUs) and line departments have facilitated the formation of FPCs across the country. As per SFAC website, 52 FPCs have been established so far in Tamil Nadu. The present research study was, therefore, taken up with the objective of making a comparative analysis of the processes of formation of three FPCs, one each facilitated by NGO, Tamil Nadu Agricultural University (TNAU) and Department of Agricultural Marketing.

## METHODOLOGY

The Ramnad Pesticide Free Chillies Producer Company Ltd (RPFCPCL), the first FPC incorporated in India during 2004 in Ramnad District which was facilitated by a NGO, Dhan Foundation, Madurai, Ayakudi Guava and Fruits Producer Company Ltd (AG&FPCL) incorporated in the year 2014, in Dindigul District, facilitated by the TNAU and Dharmapuri District Minor Millets Producer Company Ltd (DDMMPCL) incorporated in the year 2015, in Dharmapuri District facilitated by the Department of Agricultural Marketing and Agribusiness were selected for the study.

Based on a pilot study of the Velliangiri Ulavan Producer Company, Coimbatore District, a checklist was prepared on the processes of formation such as awareness creation, discussion, exposure visits, opportunity identification, motivation, facilitating, co-operation, convincing, success stories, learning from experience, exposure visits, study tours and utilizing consultants.

Data were collected during March - May, 2015 by conducting Focused Group Discussions (FGDs) in the registered offices of the FPC concerned and 23 Member respondents of RPFCPCL, 19 Member respondents of AG&FPCL and 29 Member respondents of DDMMPCL, making a total of 71 respondents participated in the FGDs. The respondents included Directors as well as other Members representing different villages. In the FGDs, the respondents were asked to recall who did what, when, where and how with focus on the various actors, activities and interventions made over a period of time that led to the formation of the Company. The entire proceedings of the FGDs were recorded with voice recorder. After going through the recordings, the process aspects were then noted, sequenced and documented.

## FINDINGS AND DISCUSSION

The process related activities and interventions made by different actors that led to the formation of the three Farmer Producer Companies are presented below:

**Chart 1: Sequential processes of formation of Ramnad Pesticide Free Chillies Producer Company**

❖ In 1993, Dhan Foundation, a NGO, selected Ramnad District for agricultural development through its Vayalagam Project

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- ❖ Conducted village level meetings, focused group discussions, livelihood PRAs, brainstorming sessions and exposure visits.
- ❖ Established 50 Farmer Producer Societies each comprising 15 – 20 members in several villages
- ❖ Dhan Foundation, KVK, line departments and Farmer Producer Societies developed an action plan for increasing production of crops and income of farmers
- ❖ Formed SHGs to access credit by themselves and to avoid the exploitation by the money lenders
- ❖ Educated the farmers on water conservation methods, salinity management technologies which were adopted by the farmers in a big way
- ❖ Tanks were renovated in a participatory manner and water storage capacity increased
- ❖ By 2003, in ten years time, farmers could collectively work together and enhanced production of crops by tackling water scarcity and salinity problems
- ❖ The farming community at large gained strong belief in Dhan Foundation's philosophy of triggering development through empowered social institutions
- ❖ Dhan Foundation and farmers saw great opportunity for promoting the cultivation of local 'Mundu' variety of Chillies
- ❖ Farmers were individually selling Chillies to local buyers and traders for lesser price
- ❖ Dhan Foundation educated the farmers on the scope and benefits of forming Farmer Producer Company especially for the collective production, processing and marketing of Chillies
- ❖ Meetings were conducted in the respective Farmer Producer Societies to convince the Member farmers to form a Farmer Producer Company
- ❖ The first Farmer Producer Company in India by name 'Ramnad Pesticide Free Chillies Producer Company' was incorporated on 05.08.2004 with 770 members each paying Rs.200 as share amount for 20 shares @ Rs. 10 per share

The major processes of RPFCPCL were organizing farmers into Farmer Producer Societies and Self Help Groups through meetings, FGDs, livelihood PRAs, exposure visits, stakeholders meetings and consultative meetings, facilitating the farmers to enhance production and quality of produce through social institutions and inculcating confidence and belief in the NGO as a result of the desirable impact of the developmental activities that helped to tackle water scarcity and salinity problems. Identification of the potential opportunity for collective production and marketing of local Mundu variety of Chillies and motivating the Farmer Producer Groups to form FPCs by convincing the farmers to take up farming as a business venture with the technical, financial and marketing capabilities was the other salient processes of formation.

**Chart 2: Sequential processes of formation of Ayakudi Guava and Fruits Producer Company**

- ❖ In 2009, Dr. T.N.Balamohan, TNAU, selected 25 guava growers in Old Ayakudi, Dindigul District for implementing project on Value Chain Management of Guavaunder National Agricultural Innovations Project (NAIP)
- ❖ TNAU Scientists conducted SWOT analysis and trainings on improved guava production technologies to build technical capacity of the farmers
- ❖ In February 2010, the farmers were trained on post harvest and marketing of guava at Horticultural College and Research Institute, Coimbatore
- ❖ In July 2010, Buyer – Seller Meet was organized which enabled the farmers to know the expectations and preferences of buyers and the great demand for quality guava fruits
- ❖ In August 2010, Stakeholders Meet was conducted in Old Ayakudi involving farmers, line department officials, TNAU Scientists and bankersto tap the production potential, access credits and collectively market
- ❖ In early 2011, capacity building programmes on guava packing, high density planting, pre-flowering technologies, supply chain management and export procedures were conducted in collaboration with Indian Horticulture Development Alliance (IHDA)

- ❖ In 2012, Farmers Experience Sharing Workshops were conducted in collaboration with IHDA and Confederation of Indian Industry during March and May respectively.
- ❖ In 2012, demonstrations on micro and macro nutrients and use of fruit fly traps control were conducted.
- ❖ In 2013, two more Buyer – Seller Meets were organized attendedby 250 number of farmers and buyers.
- ❖ In May 2013, trainings on Farmer Producer Company for guava and Market Led Extension were conducted in Old Ayakudi attended by 89 guava growers When the NAIP project was coming to a close, Dr.E.Vadivel, Principal Investigator and Dr. T. N. Balamohan motivated the project beneficiaries to form a FPC.
- ❖ In August 2013, exposure visit was conducted for 36 guava growers to Erode Precision Farm Producer Company Ltd at Sivagiri to learn about the formation of Farmer Producer Company.
- ❖ On 27th Aug 2013, Producer Company Stakeholders Meet for guava was conducted at Old Ayakudi.
- ❖ In September 2013, a meeting with TNAU Scientists, Deputy Director (Marketing) and farmers was conducted to discuss on the modalities for establishing guava fruits packing unit and sales counter.
- ❖ On 03.01.2014, the Company named Ayakudi Guava and Fruits Producer Company was incorporated with 103 members each paying Rs.5000 as share amount making a paid up capital of Rs.5,15,000 and inaugurated by Dr. Ezekiel, National Coordinator (NAIP).

The TNAU, Coimbatore served as a spark plug for the formation of AG&FPCL. Selection of 25 guava growers as beneficiaries under NAIP Project, conducting trainings and demonstrations to build technical capabilities of the farmers on improved and latest technologies for enhancing production and quality of guava fruits, grading and packing, organizing buyer-seller meets and stakeholders meets involving scientists, farmers, line department officials, buyers and traders were the salient processes that convinced and motivated the farmers to take a collective decision to form the Company.

**Chart 3: Sequential processes of formation of Dharmapuri District Minor Millets Producer Company**

In 2010, Mr. Thomas, AO (Agricultural Marketing), Dharmapuri, took a group of 28 farmers led by Mr. Sivalingam to Center for Indian Knowledge System, a NGO in Chengalpattu for training on Natural Farming and Organic Certification.

- ❖ The trained farmers formed an Association and produced organic vegetables, namely, bitter gourd, snake gourd, ribbed gourd, tomato, brinjal and capsicum
- ❖ Other farmers in the region were highly skeptical about the success of this venture
- ❖ During 2010-12, a group of about 25 farmers produced organic vegetables and sold for Rs. 34 lakhs to the local traders
- ❖ Mr. Thomas took the farmers to M.G.R. Market at Coimbatore along with organic vegetables produced by them
- ❖ The traders at M.G.R. Market paid higher price to the organic vegetables due to pleasant odor and high quality
- ❖ The success made by the vegetable growers created confidence among other farmers who were cultivating millets, namely, ragi, cumbu, panivaragu, samai, thinai, etc.,
- ❖ Marketing of millets was fully influenced by the traders and middlemen, compelling the farmers to sell at lower price
- ❖ The officials of the Marketing Department convinced the millet growers through discussion meetings to form a Producer Company for millets repeating the successful experience of collective production and marketing of organic vegetables
- ❖ Mr. Sivalingam and nine other progressive farmers conducted a series ofmeetings in their respective villages to motivate other farmers
- ❖ Facilitated by the Department of Agricultural Marketing, 50 Millet Farmer Producer Groups each consisting of 15 -20 members covering 200 villages were formed
- ❖ Ten leading farmers were identified as Directors and each was given a target of bringing 100 more members

❖ The Dharmapuri District Minor Millet Producer Company was incorporated on 05.03.2014 with 234 members each paying Rs. 1000 as share amount
❖ In May 2014, the membership increased to 1000 with authorized share capital of Rs. 10 lakhs

The initiatives taken by the Department of Agricultural Marketing and Agribusiness for training and facilitating farmers to collectively produce and market organic vegetables, arranging exposure visits, identifying the opportunity for collective production and marketing of millets, repeating the successful experience of production and marketing of organic vegetables and utilizing the lead farmers to convince more farmers were the salient processes to form the FPC.

## CONCLUSION

The present study reveals that the important processes for the formation of FPCs were creating awareness, building confidence, convincing, identifying appropriate opportunity, building technical and marketing capacities through trainings, demonstrations, exposure visits, facilitating the establishment of Farmer Producer Groups and Self Help Groups, imparting business attitude and skills and sharing the opportunities for availing government support and financial assistance and making farming profitable through collective production, value addition and marketing. A combination of the above mentioned processes has to be appropriately chosen by the external catalyst agency while facilitating the formation of a FPC by NGO or University or line department.

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**RESEARCH ARTICLE**

# An Process Analysis of Erode Precision Farm Producer Company in Tamil Nadu – A Case Study

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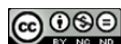[2]Professor (Agricultural Extension), Directorate of Open & Distance Learning, TNAU, Coimbatore - 3.

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## ABSTRACT

The present process study was conducted to explore the processes of formation and functioning of Erode Precision Farm Producer Company Ltd and to know their future plans and expectations. The study was carried during May, 2015 by conducting Focused Group Discussion with 40 Members using a checklist prepared on the process aspects. Data were also collected through personal visits to the farmers' fields in the 15 clusters and the constituent units of the Company, namely, the Input Shop and Kisan Seva Kendra. The salient processes found out were the catalytical role of Tamil Nadu Agricultural University, line departments and private agro companies in building techno managerial and marketing skills through trainings, demonstrations, exposure visits, negotiations, conducting field experiments etc., Identification of opportunities, adoption of improved technologies, coordination among the clusters of collective production, grading, processing and marketing were the other processes for the success of the Company.

**Key words:** analysis, FPO, Precision farming , Focused Group Discussion.

## INTRODUCTION

Ministry of Agriculture, Government of India has identified the Small Farmers Agribusiness Consortium as a Nodal Agency to promote Farmer Producer Organizations (FPOs) across the country and link producer groups to marketing opportunities. During the 12th Plan period (2012-2017), the Small Farmers' Agribusiness Consortium (SFAC) aims to further promote POs (GOI, 2013). The Government hopes that this will foster technology penetration, improve productivity, enable improved access to inputs and services and increase farmer incomes. Producer

Organizations (POs) are successfully strengthening the economic position of their members by providing agricultural inputs, credit, processing and marketing services (Narayanan and Gulati, 2002). Organizing farmers into specific producer groups also improves the effectiveness and efficiency of agricultural extension systems in supplying relevant commodity or product-specific information and training directly to farmer groups who are producing particular crops or products (Swanson, 2008). Globally, POs are also increasingly recognized as an important actor in the Agricultural Innovation System (FAO, 2010).

After the amendment of Companies Act 1956, in the year 2002, several agencies, namely, Government Organizations, State Agricultural Universities, Non-Governmental Organisations and Farmers Organisations have established FPCs throughout India and as per the SFAC website, 49 FPCs have so far been incorporated. Recently, Government of India has approved Resource Institutes in different States to facilitate the establishment of FPCs through conduct of trainings and meetings to inculcate technical, management and marketing skills among the farmers.

The present study was, therefore, taken up to identify and document the sequential steps and processes followed for the formation and functioning. Another aim of the study was to explore the future plans and expectations of Erode Precision Farm Producer Company Ltd. the findings of this study will serve as a guiding force for effectively promoting the FPCs in the coming years.

## METHODOLOGY

The study was conducted during May, 2015. A checklist was prepared on the processes of formation and functioning such as awareness creation, discussion, exposure visits, opportunity identification, motivation, facilitating, co-operation, convincing, success stories, learning from experience, exposure visits, study tours and utilizing consultants. A focused group discussion (FGD) was conducted in the registered office of Erode Precision Farm Producer Company Ltd at Sivagiri with 40 farmer Members including 15 Directors and farmer Members representing all the 15 clusters.

In the FGDs, the respondents were asked to recall who did what, when, where and how with focus on the various actors, activities and interventions made over a period of time that led to the formation of the Company. Personal visits were made to the farmers' fields, Input Shops and Kisan Seva Kendra to get the details relating to the processes, future plans and expectations. The entire proceedings of the FGDs were recorded with voice recorder. After going through the recordings, the process aspects were then noted, sequenced and documented.

## FINDINGS AND DISCUSSION

### Process of formation and functioning

❖ In the early 2000s, Tamil Nadu Precision Farming Project was implemented in Dharmapuri and Krishnagiri districts by TNAU with funding support from Tamil Nadu State. Subsequently the project was scaled up across the state with the financial assistance from, National Agricultural Development Project (NADP).

❖ As an outcome of this very successful project the "Dharmapuri Precision Farmers Agro Service Limited" was incorporated in the year of 2007 by the Precision Farming Farmers in Dharmapuri district for the purpose of procuring and selling Agro inputs to the farmers.

❖ In the effort to upscale the project across the State of Tamil Nadu, the Precision Farming demo project was implemented in Sivagiri area of Erode district in 150 ha.

❖ After the exposure visit to Dharmapuri Precision Farmers Agro Service Ltd., the farmers of Sivagiri were interested in starting an Input Shop in Sivagiri area. An open call was made for all the farmers of the region, but

only 50 farmers from Kodumudi and Modakuruchi block came forward to start the Input Shop. With this 50 farmers the Erode Precision Farm Producer Company Limited was incorporated on 16.10.2008 with an authorized share capital of Rs.10 lakhs.

❖ Many farmers were reluctant to join the company due to the reason that some of their relatives were already owning input shops and having long term transaction with them. Further, many used to get inputs on credit from other retailers while the credit sale was not entertained at this company.

❖ Each of the 50 farmers paid Rs.10,000 as share money (at the rate of Rs.100 per share x 100 shares) making a total capital of Rs.5 lakhs and the Input Shop was opened in the year 2008.

❖ In the year 2009, as the share capital amount of Rs. 5 lakhs was insufficient to run the Company, it was decided in the Annual General Meeting (AGM) to bring-in 50 more Members.

❖ Due to the success and reputation already made, additional 50 members joined the Company willingly by paying a share amount of Rs. 10000 plus Rs 2,500 as premium enhancing the paid up capital to Rs. 10 lakhs.

❖ It was always ensured that only quality agro inputs were distributed to the farmers. Farmers were also educated on right diagnosis of pest and disease problems and application of right kind and quantity of pesticides. In all other shops, unnecessarily two or three pesticides or fungicides were given for managing a particular disease or insect which was more expensive to the farmers. But in EPFPCL Input Shop, only high quality products from reputed firms were purchased and sold to the farmers. Another mechanism followed by EPFPCL was that whenever any new input was introduced by any Company, the same was tested in about five to ten farms and based on the results only it would be procured and sold.

❖ The member farmers of the company gave suggestion to a private agricultural machinery firm to modify the tractors with provision for attaching sprayer and to increase the HP from eight to ten for easy operation. The tractor company has accepted the suggestion and assured to do the needful.

❖ In September 2011, Indian Oil Corporation called for Kisan Seva Kendra (KSK) and EPFPCL decided to utilize this opportunity to open Kisan Seva Kendra which would house petrol bunk and also Input Shop for which an amount of Rs. 40 lakhs was required.

❖ A decision was taken to collect an additional amount of Rs.30,000 from the existing 100 Members who have already paid Rs. 10,000 for 100 shares. To meet the requirement of Rs.40 lakhs it was again decided to increase the membership of the Company by receiving an amount of Rs.45, 000 for 400 shares (Rs.5000 as premium)

❖ At this point of time, the number of members of the Company rose to 150 with 15 Directors at the rate of five Directors per 50 members.

❖ With the available share capital, the KSK was started on 13.07.2012 in a rented place.

❖ Inspite of heavy competition with many individuals, the EPFPCL was sanctioned with KSK only because of its strength as a Company. This was a moral boost to all the Members and it brought better image and reputation for the Company.

❖ Fifteen clusters were formed each headed by one Director for a tenure of two years.

❖ The EPFPCL has become the dealers for many reputed frims including M/s Jain Irrigation system.

❖ Turmeric, Sesame, Sugarcane, Paddy, Groundnut were normally cultivated by the farmers.

❖ When a group of members visited Chennampatty of Bhavani Taluk to study the possibility of cultivating Kadhali and G9 varieties of banana they also saw good prospects for the growing of pomegranates having great demand in the market.

❖ Dr. E. Vadivel facilitated the Company for bringing 10,000 seedlings of pomegranate from M/s Jain Company for planting in Sivagiri area as an alternate profitable crop in the place of turmeric. Ten thousand seedlings were planted by 20 farmers each in one acre.

❖ Gradually, the area has increased to 150 acres with 35 farmers.

❖ Market study was undertaken by a team of five members by visiting several markets in Salem, Karur, Erode, Gobi and Trichy.

❖ Then, collective marketing was done by selling pomegranates in different markets in boxes. While marketing, grading was done and price was fixed accordingly keeping into consideration the prevailing market rates in various places.

❖　Collective cultivation of pomegranate enabled the farmers to get remunerative prices on one hand and to get technological support to manage the pest and disease problems in all the fields at the same time.

❖　Experts from different organizations such as IIHR, TNAU, M/s Jain etc., were invited every month to diagnose the pest and diseases of pomegranate and to get immediate solutions.

❖　Based on the suggestions and facilitation of Dr. E. Vadivel and Scientists of TNAU, the Members took up vegetable cultivation in a big way under precision farming.

❖　EPFPCL was recognized as a Resource Institute by the SFAC, Government of India in February, 2013. Even before becoming a Resource Institution, EPFPCL facilitated the formation of several FPCs in Tamil Nadu such as Cumbum Valley Fruits and Vegetables Producer Company Ltd., Ayakudi Guava and Fruits Producer Company Ltd., Kovai Farmers Producer Company Ltd., and Rajapalayam Precision Farmers Producer Company Ltd., TN State Banana Producer Company ltd., Velliangiri farmers Producers Company Ltd., etc

❖　As Resource Institution, EPFPCL has now established producers Companies for pulses and millets in Tiruppur, Erode, Salem, Tiruvarur and Namakkal.

❖　The EPFPCL started offering one day training programme at a charge of Rs. 5000 for the farmers from other areas who were interested in forming FPC. All details including the procedures for incorporation of FPC and a tentative business plan were suggested during this training programme.

❖　In early 2015, a farmer preferred to sell the share 400 Nos worth Rs.40,000 and the highest bid was Rs.75,000. At present the value is Rs.1,00,000.

**Future Plans**

❖　Buy one acre of land for the company
❖　Establish multi commodity processing unit as food industry is a sunrise industry.
❖　Be the franchise for e Kisan Mandi in Tamil Nadu under SFAC and be the aggregator for the commodity.
❖　Import quality inputs and export pomegranate to Far East.
❖　Buy two trucks for transport service.
❖　Construct ware house for storing of Commodities.

**Expectations**

❖　Net work with rest of the producer companies in the State and be a dealer for the produces from them and be a supplier to all FPCs who shall become dealers for our products.
❖　Take a lead role to promote State Level Producer Company Ltd., with all other FPOs as share holders.
❖　Get linked to Bharat Kisan Producer Company Ltd of India and emerge as an institutional mechanism similar to Confederation of Indian Industry.
❖　Mobilise large parcels of land for cultivation by the company for better productivity and profit.

## CONCLUSION

The synergetic efforts taken by different stakeholders, namely, farmers, TNAU, line departments and private agro companies for systematically building technical, management and marketing skills through relevant activities and interventions such as meetings, trainings, exposure visits, conducting feasibility studies, negotiation, opportunity identification, developing business plans, risk orientation, conducting field experiments, use of ICT tools etc would serve as a handy reference to the FPC promoting agencies who have to tactfully apply a suitable combination of such processes depending upon the farming situation and socio psychological framework of the farmers.

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**RESEARCH ARTICLE**

# The Effect of Schools' Outdoor Design on Improving the Quality of Students' Learning in High Schools of Zanjan City

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**ABSTRACT**

Human being across his life receivesmessages containing information from thesurrounding environment and learns them, whether the environment is natural or artificial. Whatever the messages are more accurate and categorized the learning ability of individualswould be higher. In this context, the impact of architecture, i.e. the art of surrounding, in terms of exposure in different environmentschanges the desire to learning, sensitivity to environmental stimuli, focus to and motivation for education. In environments that are designed specifically for training, this effect should be located at the heart ofthe focus of designers'attention and by studying behavioral patterns of children to design details and effective environmental features on their sense. According to the assessment performed on the schools of Zanjan city, it was found that all the attention of planners and designers was only focused on the internal spaces, and the open spacessuch as yard, garden and so on wereneglected, whereas the outdoor spaces can have important impacton the progress of scientific and educational objectives. This study was designed to address the effect of schools'outdoor designs on improving the quality of students' learning. Methodology used here is descriptive-survey and the correlation. The population included the employees and students of conservatories of Zanjan city and to select a sample of the population the stratifiedsampling method was used.The results suggest that school facilities, in particular in the development and design of outdoor spaces, have the greatest impact on improving the quality of students'learning. Thus, developing solutions for better designing of yards with consideration

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oflimitations and facilities, correctingthe current flawed approaches and moving towards an optimal approach for improving the quality of learning are among contributions of the research.

**Key words**: outdoor design, learning, training environment

## INTRODUCTION

One of the effective factors in modern education and training is the architecture of physic and space in schools. In modern education, the school's physic and space should be such thatasa dynamic factor play role in the quality of education and training activities. This means that school's educational activitiesshould be performed in appropriate places with standard dimensions and according to the needs and interests of students. In such an environment, teachers and students feel more motivated for learning and enjoy of their activities (Tabatabaianet al., 2011).

The Architecture of schools and principles and elements constituting itsuch as proportionality of ingredients, scale, type of spaceorganization, color, light, open space etc. can have significant effects on students. Beauty of school makes learning easier and provides the children and adolescents with the joy and happiness. Conversely, inappropriate, small, cramped, dark and lifelessschool would provide the students with depression and will have a negative impact on their learning and their active and joyful participation in school (Khalesi, 1997).

Good physical space is a spacethat makes better learning possible and increases normal behaviors ofpeople who use it. In the psychology of environment, a significant number of researches are done on the characteristics ofproper physical locations where people can satisfy their needsto relax, have fun, to eat, to study and so on. For example, experts in environmental psychology have paid much attention to the impact of environmental conditions on education.

Observations made in this regard show that some places can make more progress in training. Accordingly, Edward T. Hall (1966), an expert in communication, in his main theory, i.e. "silent language", believes that "spacespeaks"and "time speaks". This means that learning does not happen only in the classroom, but also the school's doors and walls similar to teachers and books include carry messagefor students and speak with the children and adolescents. Thick and narrow walls and narrow and long corridors induce the sense of being imprisoned, whilea courtyard filled with flowers and trees as well as clean classrooms, which has good colors and pleasant peace, induce the sense of joy and happiness (NavidAdham, 1996).

Architectural is an art that has surrounds us and people more than effecting on the environment are affected by. As psychologists in educational issues usually emphasize on a variety of factors such as families, teachers, teaching methodology, textbooks, educational management and so on as effective factors on the educational process, consider also the architecture or the physical space of school as a dynamic factor which affect the quality of students' education and training activities (Lotfata, 2008).

**The research process**

**Research objectives**

The purpose of this study was to review the interaction between the internal and external spaces of schools and optimal design of yard spaces in line with education goals and with the aim of improving the quality of learning and strengthening mental and physical powers of students.

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In a general view, we can refer to the following factors as objectives of Architectural design section:

**The main objective**: to propose solutions for promoting the quality of students' learning in outdoor spaces of girls' conservatories,

**Subsidiary objective**: to identify the environmental factors affecting improvement of students' learning.

**Research questions**

How much the school's yard is effective on improving the learning quality of students?

Which factors should be existed in the school's yard to improve the quality of learning?

What the relationship exists between indicators of school's outdoor, e.g. suitable design of entrance, the physical space of the yard, green space, the right regulation of the yard for education, and the learning of students?

## RESEARCH METHODOLOGY

Methodology used here is descriptive-survey and correlational. The purpose of application studies is to developthe practical knowledge in a particular field. In other words, applicationsaim at scientific application of knowledge. Descriptive researches involve collecting information to test hypotheses or give answer to questions relating to the current situation of the subject of study. A descriptive study explainsand reports about the current situation.Correlation studies test the relationship between variables, but they do not necessarily explore the causal relationship between variables. In the correlation studies, emphasize is at finding the relationship between two groups of data.

## REVIEW OF LITERATURE

**Factors affecting the learning of students**

If you examine the life of a student, we conclude that he spent much of his time and energy on learning. Evenstudents, who seem to be indifferent and non-motivated, expose a lot of stress and concern about theirlearning. In adolescence, success in school is one of the joyfulissues. In order to increase the effectiveness and efficiency of the learning-teaching process, in this section, somefactorseffective on the learning of students is examined. Student-teacher interaction, participation of student in class and school activities, teaching and teacher valuationmethods, course content, school facilities and school atmosphereare among issues we have addressed in this section.

Quality of open space is consideredas the main purpose of the questionnaire.

**Student-teachersinteraction**

Formal and informal communication of students with school staff and especially with teachers about school's events can activities can be considered as a partial tool to increase motivation and self-esteem among students. Good teaching of teachers and good communication of them with parents and keeping them informed as well as getting information and feedback of them can be an effective mechanism in creation of an effective relationship between school, home and finally the student's sense of comfortable (Torkzadeh, 1999).

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The following cases are examples of the communication methods in a typical school:

Exposing concern and giving attention to students
Presence of teacher in additional programs
Meeting of teachers with parents
Holding meeting for teachers, students and parents (Abbasi, 2004).

Emotionalcompassion and coordination among teachers and students show the intimacy between them. The closer the coordination between teachers and students is, the higher the intimacy and passion between them will be (Abbasi, 2004).

**Participation of students in class and school activities**

Students not only are part of the school community, but also they are part of the larger community. Student is in interaction with her school's environment, student and peer groups inside and outside the school so that they can interact several hundredtimes each day. Social atmosphere of the school, the classroom and in general the community has practically important influence on students' behavior and progress (Torkzadeh, 1999).

When students found themselves efficient and autonomic in their homework will engage increasinglywith goals and homework and thus can become successful in education. In addition, when students seem themselves as qualified and control their assignments, their internal motivation for conducting school assignments will increase. To make students participated in school, it is necessary that in each training unit, appropriate and clear systems to be chosen. The easiest way in this context is to formgroups of volunteer students leading by one or more interested and capableteachers and staff in different field of work in school such as early morning ceremony, celebrations and important events such as the parent-teachers association meeting, sports, extracurricular activities, school's buffet, school's security and so on (Torkzadeh, 1999).

**Teaching methods and teacher evaluation**

Teaching is essentially a two-way process, in which the role and the amount of activity depend upon various ways of its application. Some people have mentioned teaching as an interaction and decision-making process. In this type of interaction, the instructorattempts by planningto provide thefavorable change conditions in learners(Pishgar, 2003).

The purpose of activating learners is to promote their creativity, which follows by joy and self-confidence. Efficient teachershave learned the importance of problem solving in uplifting the studentsand they emphasize on inclusion of problem solving skills in various ways in the curriculum. In this way of teaching, the teacher should teach materials for the students for the students in terms of questions or to encourage them for asking questions and then to provoke their interest for problem solving (Abbasi, 2004).

**Course content**

Among the most important issues in improve learning and creating intrinsic motivation for learningis the linkage between course material and students' life. First, educational materials must be closely correlated with the life of students, rather than including a series of abstract incomprehensible materials. Second, teachers when teaching should relate the educational material to thedaily practical lifeof learners. John Dewey suggested that emotionallythe biggest disadvantage of the current system is not poverty and its various consequences, but rather is that people engage in training and activitiesthat are not interested in them. According to him, whenever the program of school's activities and the content of courses is based on the desire of students (including four factors: desire for social contact,

desire to search and investigate things, desire to activities and desire to art), learning and all the educational activities will become funny and joyfulfor students (Karimi, 2001).

### School'sorganizational atmosphere

The task and mission of education organizations and schools is that by using innovative and creative managers and offering new designs and new approaches to make the school atmosphere to thriving, creative, innovative, warm, intimate, effective, high-effort, coordinated and joyful (Safi, 1995).

School atmosphere is the result of efforts and mutual relations and practices among the internal groups within schools such as administrators, teachers, staff and students. Beside working and doing effort, they also attempt to make a balance between personal and cultural structural dimensions of the school system. The result of these efforts and mutual affections is the formation of values, beliefs and social norms of the school (Alaqeband, 1998). Research findings show that organizational health is correlated with students' performance in school. The healthier the school's atmosphere is, the higher the level of student's achievement in math and reading courses will be (Hovi, Miskel, 1999).

### Educational facilities

One of the main missions of education and training is provision of a favorable education environment in terms of physical dimension, which can be effective in the perception of students and consequently in their academicachievementsas well as internal motivation.

Arthur et al. pointed out to the importance of the impact of the physical condition of the school and class on the behaviors and the ability of students to learn. In their viewpoint, the importance of the physical condition of the school and class is because students and teachers spend much of their life in school, thus, the school and the class must include features like comfort, attractiveness and being stimulating. Increased brightness and better distribution of it across classes, the use of heating, cooling and better ventilation, the use happy and bright colors on the walls, doors, windows, tables, benches and developinggreen space of schoolsprovides attractive and desirableatmosphere and by creating joy and happiness prevent students to feel malaise and fatigue (Arthur et al., 1993). Insome cases, improving the physical environment of the school leads directly to the improvement of motion and sensorytraction, sometimes strengthens their spirit, and indirectly affects their effectiveness (AleYassin, 2001). Thus, planning to improve the physical facilities of the school is as much essential as planning forthe educational affairs of the school (Simpelekeh, 2001). Although it is possible that some people may be able toadapt themselves with harsh environments, but laboratory studies have shown that when a person often is faced with annoying or harmful success will suffer of is the more muscle tensions, which lead to increased consumption of energy and thus sooner fatigue (AleYassin, 2001).

Light is another important factor that because of its importance in improving student's performance is being considered by researchers.Results of studies suggest that academic performance of students who mostlyuse of the natural lightis better than that of student who less use of natural light; the rate of absenteeism follows the same pattern (Nesea, 2001).

### Tools and methods of data collection

Data needed for the study were collectedby two methods:

**Library method**: in this method to collect data, we refereed to the first and second chapters of books, domestic and international scientific articles as well as databases relating to the subject,

**Fieldmethod**: in this study, a questionnaireprepared and designed and then distributed among the participants, where by the needed information were collected.

### Population

In this study, the population is consisted of female students studying at conservatories of Zanjancity as well as staff teaching there. We can say that units of population are relatively heterogeneous and there are significant differences between them in terms of their answers to the questions, because it may bepossible that people providing and receivingservicesto have different comments about services provided by the conservatory. On the other hand, as we will say in the next section, the accuracy of stratified sampling is more than that for other conventional sampling methods. Thus, it must be said that the best sampling method in this research is stratified sampling one. To this end, we consider the students studying in the conservatories of Zanjancity as a class and the teaching staff of these conservatories as the other category. Thus, the population of our study is divided into two classes, in which units of every class of society is homogeneous.

### Reliability of the questionnaire

Toensure of the reliability of the questionnaire, a pre-test was conducted, in which 10 questionnaires were analyzed using Cronbach's alpha. The zero value for this factor indicates the lack of reliability and +1 indicates full reliability. Typically, values greater than 7.0 for this coefficient can confirm the reliability of the questionnaire. After conducting the test for the overall reliability of the questionnaireand its main indexes (Table 3.1), the value of 0.956 obtained which shows the amount of questions' accuracy.

### Data analysis

### Research's variables

In this section, factors obtained fromthe exploratory analysis with respect to the advices of teachers were classified and namedand then used to test research's hypotheses.

### Testing research's hypotheses

In this section, using multifactor analysis of variance, the difference between the indices of the study is review and in order to assess the uniformity and naturalness of data, Kolmogorov-Smirnov test and Levine test are used, respectively. Also to examine the relationship between research's variables(correlation), the Pearson's test was used.

### Examining normality of data

After collecting the questionnaires and encoding the data, Kolmogorov-Smirnov test was performed to verify the normality of population. Given the significant level of all variables is greater than 0.05, the hypothesis of normality of observations, i.e. the null hypothesis, do not reject. Then, given that the observations follow a normal distribution, parametric methods are used to analyze data.

**Levine test**

Given the normal distribution of data to examine the homogeneity of variances, Levine test was used and resultsarelistedin Table 4.

**Multifactor ANOVA**

According to Levine test, we can see that the variance of the data is homogeneous. Accordingly, given the homogeneity of variances, to test the hypothesis that whether research's variables are different in the two groups, the multifactor analysis of variance is used (Table 7.3).

According to Table 5, we can see that there is significant differencebetween the two analyzed groups for the variable of interaction (P = 0.000).

According to Table 6, we can see that there is significant difference between the two analyzed groups for the variable of participation (P = 0.000).

According to Table 7, we can see that there is significant difference between the two analyzed groups for the variable of teaching methods (P = 0.000).According to Table 8, we can see that there is significant difference between the two analyzed groups for the variable of course content (P = 0.000).

According to Table 9, we can see that there is significant difference between the two analyzed groups for the variable of organizational atmosphere(P = 0.000).

According to Table 10, we can see that there is significant difference between the two analyzed groups for the variable of educational facilities (P = 0.000).

**Hypothesis 1**: participation in class and school activities has significant effect on the learning of students.

As shown in Table 11, the correlation between the learning and participation in school is equal to 0.772, which is significant. Thus, the hypothesis is confirmed.

**Hypothesis 2**: course content has significant effect on the learning of students.

As shown in Table 11, the correlation between the learning and course content is equal to 0.744, which is significant. Thus, the hypothesis is confirmed.

**Hypothesis 3**: student-teacher interaction has significant effect on the learning of students.

As shown in Table 11, the correlation between the learning and student-teacher interaction is equal to 0.778, which is significant. Thus, the hypothesis is confirmed.

**Hypothesis 4**: teaching method has significant effect on the learning of students.

As shown in Table 11, the correlation between the learning and teaching method is equal to 0.803, which is significant. Thus, the hypothesis is confirmed.

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**Hypothesis 5**: school's organizational atmospherehas significant effect on the learning of students.

As shown in Table 11, the correlation between the learning and school's organizational atmosphereis equal to 0.728, which is significant. Thus, the hypothesis is confirmed.

**Hypothesis 6**: educational facilities has significant effect on the learning of students.

As shown in Table 11, the correlation between the learning and educational facilities is equal to 0.845, which is significant. Thus, the hypothesis is confirmed.

According to the results of Pearson's test (Tables 11 and 17), it can be concluded that all the six independent variables of the study, i.e. participation in school and class activities, course content, student-teacher interaction, teaching method of teachers, school's organizational atmosphere, and school's facilities, play role in the promotion of learning.

**The main hypothesis**: the outdoor space of schools has significant impact on the learning of students.

According to the following table, itcan be said that factor of the development of appropriate open space in school's environment has the greatest impact on increasing the learning of students.

## FINDINGS

The design of a favorable outdoor space, which meets the needs of students for enhanced learning during the school year,was the main motive forthepresent study. In the previous stage, the outdoor of schools was investigated through interviews with high school students of conservatories of the field of research's survey. Afterwards, in order to achieve outdoor design's criteria, a questionnaire was prepared and given to the students. The aim of designing the questionnaire is thatby reviewing answers received to identify definition of school's yard from the viewpoint of students. This step is considered as an initial decision in the field of architectural design of school's yard to complete the next steps. The proposed results are resulted from the survey Tables filled by students.

## CONCLUSION

In general, to measure the impact of outdoor design on the quality of learning, researchers has considered factors such as student-teacher interaction,participation of students in school and class activities, teaching and evaluation method of teachers,course content, school's organizational atmosphere, and school's facilities. As the statistically results have shown, outdoor space of schools as an educational facility improves the quality of learning in student. Given the importance of open space in providing all-round growth of studentsas well as the main problems and weaknesses of the current approach in the design of school's yard, consideration of the environmental factors in the outdoor of schools in improving the quality of the learning is evident. Thus, in this study as a preliminary decision on architectural design of school's yard, solutions are proposed to be completed in the next steps.

Development of school's yard needs to be holistic, sustainable and participatory. According to researchers, alienation to the nature causes increases the disorder of attention in students and consequently leads to the increased stress and reduced learning. Since they understand through direct experience with the surrounding environment, we should be able to put the potential associated to environment at the service of them. Based on the results, student in the face with the environment will become sensitive to all aspects of the environment and all their senses will be activatedin the process of communication with the environment, something that should be considered by designers. This leads to a more complete understanding of the environment and in turn will result in increased progress of student.

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**Suggestions**

Researchers on the basis of the literature studied as well as findings of present study provide offer the following suggestion for being used in the designing the architecture of training spaces:

Conducting researches like this in other educational levels and even universities with the aim of developing an effective environment for promoting learning

The combination of outdoor and closed spaces and classification of relevant spaces to each of them as well as defining roles of them in the promotion of learning

**Appreciation**

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**Table 1: Cronbach's alpha test**

| Questionnaire's indicators | Cronbach's alpha |
|---|---|
| Questionnaire's questions | 0.956 |

**Table 2: Description of research's variables, source: authors**

| Variable | Count | Average | Mean | Variance | Average SD |
|---|---|---|---|---|---|
| Interactions | 160 | 3.0313 | 2.00 | 0.981 | 0.990 |
| Participation | 160 | 2.8670 | 3.43 | 0.661 | 0.813 |
| Teaching methods | 160 | 3.1677 | 3.00 | 0.874 | 0.934 |
| Content | 160 | 3.0172 | 2.63 | 0.700 | 0.836 |
| Atmosphere | 160 | 3.0333 | 2.50 | 0.664 | 0.814 |
| School facilities | 160 | 3.9298 | 2.17 | 2.574 | 1.6 |

**Table 3: Kolmogorov-Smirnov test (examining the normality of population), source: authors**

| Variable name | Count | Significance level |
|---|---|---|
| Interaction | 160 | 0.140 |
| Participation | 160 | 0.058 |
| Teaching methods | 160 | 0.212 |
| Course content | 160 | 0.930 |
| Organizational atmosphere | 160 | 0.439 |
| Educational facilities | 160 | 0.330 |

**Table 4: Results of Levine test to determine homogeneity of variances for research's variables, source: authors**

| Significant level | df2 | df1 | F | Variables |
|---|---|---|---|---|
| 0.303 | 156 | 2 | 1.204 | Interaction |
| 0.259 | 156 | 2 | 1.361 | Participation |
| 0.207 | 156 | 2 | 1.592 | Teaching methods |
| 0.125 | 156 | 2 | 2.110 | Course content |
| 0.353 | 156 | 2 | 1.048 | Organizational atmosphere |
| 0.116 | 156 | 2 | 2.187 | Educational facilities |

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**Table 5: The results of multifactor analysis of variance for the variable of interaction, source: authors**

| Impact factor | Level of significance (P) | F | Mean square | Degrees of freedom (fd) | Total squares | Source |
|---|---|---|---|---|---|---|
| 0.355 | 0.000 | 1.787 | 1.744 | 2 | 3.478 | Modified model |
| 0.355 | 0.000 | 1.787 | 1.744 | 2 | 3.478 | Group |
| | | | 976/0 | 156 | 152.197 | Error |
| | | | | 159 | 1619.875 | Total |
| | | | | 158 | 155.685 | Modified Total |

**Table 6: The results of multifactor analysis of variance for the variable of participation, source: authors**

| Impact factor | Level of significance (P) | F | Mean square | Degrees of freedom (fd) | Total squares | Source |
|---|---|---|---|---|---|---|
| 0.462 | 0.000 | 3.708 | 2.379 | 2 | 4.757 | Modified model |
| 0.462 | 0.000 | 3.708 | 2.379 | 2 | 4.757 | Group |
| | | | 0.641 | 156 | 100.073 | Error |
| | | | | 159 | 1408.510 | Total |
| | | | | 158 | 104.830 | Modified Total |

**Table 7: The results of multifactor analysis of variance for the variable of teaching methods, source: authors**

| Impact factor | Level of significance (P) | F | Mean square | Degrees of freedom (fd) | Total squares | Source |
|---|---|---|---|---|---|---|
| 0.33 | 0.000 | 4.266 | 3.597 | 2 | 7.193 | Modified model |
| 0.433 | 0.000 | 4.266 | 3.597 | 2 | 7.193 | Group |
| | | | 0.834 | 156 | 131.526 | Error |
| | | | | 159 | 1737.361 | Total |
| | | | | 158 | 138.719 | Modified Total |

**Table 8: The results of multifactor analysis of variance for the variable of course content, source: authors**

| Impact factor | Level of significance (P) | F | Mean square | Degrees of freedom (fd) | Total squares | Source |
|---|---|---|---|---|---|---|
| 0.432 | 0.000 | 3.127 | 2.145 | 2 | 4.290 | Modified model |
| 0.432 | 0.000 | 3.127 | 2.145 | 2 | 4.290 | Group |
| | | | 0.686 | 156 | 107.006 | Error |
| | | | | 159 | 1558.844 | Total |
| | | | | 158 | 111.296 | Modified Total |

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**Table 9: The results of multifactor analysis of variance for the variable of organizational atmosphere, source: authors**

| Impact factor | Level of significance (P) | F | Mean square | Degrees of freedom (fd) | Total squares | Source |
|---|---|---|---|---|---|---|
| 0.440 | 0.000 | 1.219 | 0.812 | 2 | 1.624 | Modified model |
| 0.440 | 0.000 | 1.219 | 0.812 | 2 | 1.624 | Group |
| | | | 0.976 | 156 | 103.975 | Error |
| | | | | 159 | 1568.788 | Total |
| | | | | 158 | 105.599 | Modified Total |

**Table 10: The results of multifactor analysis of variance for the variable of organizational educational facilities, source: authors**

| Impact factor | Level of significance (P) | F | Mean square | Degrees of freedom (fd) | Total squares | Source |
|---|---|---|---|---|---|---|
| 0.238 | 0.000 | 1.421 | 3.637 | 2 | 7.273 | Modified model |
| 0.238 | 0.000 | 1.421 | 3.637 | 2 | 7.273 | Group |
| | | | 0.667 | 156 | 399.359 | Error |
| | | | | 159 | 2862.083 | Total |
| | | | | 158 | 406.632 | Modified Total |

**Table 11: Relationship between the amount of learning and participation in school, source: authors**

| Variables | The amount of learning | | | Result |
|---|---|---|---|---|
| | Count | Correlation coefficient | Probability | |
| Participation | 160 | 0.722 | 0.000 | Acceptance |

**Table 12: Relationship between the amount of learning and course content, source: authors**

| Variables | The amount of learning | | | Result |
|---|---|---|---|---|
| | Count | Correlation coefficient | Probability | |
| Course content | 160 | 0.744 | 0.000 | Acceptance |

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**Table 13: Relationship between the amount of learning and student-teacher interaction, source: authors**

| Variables | The amount of learning | | | Result |
|---|---|---|---|---|
| | Count | Correlation coefficient | Probability | |
| Interaction | 160 | 0.778 | 0.000 | Acceptance |

**Table 14: Relationship between the amount of learning and teaching method, source: authors**

| Variables | The amount of learning | | | Result |
|---|---|---|---|---|
| | Count | Correlation coefficient | Probability | |
| Teachingmethod | 160 | 0.803 | 0.000 | Acceptance |

**Table 15: Relationship between the amount of learning and school's organizational atmosphere, source: authors**

| Variables | The amount of learning | | | Result |
|---|---|---|---|---|
| | Count | Correlation coefficient | Probability | |
| School's atmosphere | 160 | 0.728 | 0.000 | Acceptance |

**Table 16: Relationship between the amount of learning and educational facilities, source: authors**

| Variables | The amount of learning | | | Result |
|---|---|---|---|---|
| | Count | Correlation coefficient | Probability | |
| Educationalfacilities | 160 | 0.845 | 0.000 | Acceptance |

**Table 17: Grouped data**

| | | y6 | y11 | y18 | y22 | y28 | y32 | y34 | y38 |
|---|---|---|---|---|---|---|---|---|---|
| N | Valid | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 |
| | Missing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mean | | 20.97 | 20.88 | 20.76 | 30.02 | 20.93 | 20.83 | 30.02 | 30.16 |
| Std. Error of Mean | | 0.1070 | 0.126 | 0.123 | 0.125 | 0.127 | 0.108 | 0.125 | 0.100 |
| Median | | 20.89[a] | 20.73[a] | 20.63[a] | 30.11[a] | 20.95[a] | 20.81[a] | 20.98[a] | 30.15[a] |
| Mode | | 3 | 1 | 1 | 1 | 1 | 1 | 5 | 3 |

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| Std. Deviation | 10.357 | 10.589 | 10.560 | 10.577 | 10.602 | 10.361 | 10.584 | 10.267 |
|---|---|---|---|---|---|---|---|---|
| Variance | 10.842 | 20.525 | 20.434 | 20.487 | 20.568 | 10.852 | 20.509 | 10.604 |
| Range | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Minimum | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Maximum | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Sum | 475 | 460 | 442 | 480 | 469 | 453 | 483 | 505 |
| [a]Calculated from grouped data. | | | | | | | | |

**Table 18: yard's spaces Disadvantageous and Solutions**

| Components of the yard's spaces | Disadvantageous | Solutions |
|---|---|---|
| **Waterfountains** | <ul><li>Congestionin water fountains because of limited taps in the yard</li><li>Creation of congestion at the entrance water fountains due to the small width of door</li><li>Long distance of water fountains from the building</li><li>Adjacency of water fountains and toilet</li><li>Use the water fountains for ablution</li><li>The height of the installation of water fountains and its construction form</li><li>Lack of proper ventilation and light for water fountains because of the small and</li></ul> | <ul><li>Decentralized location of water fountains</li><li>Close access of water fountains to the building</li><li>Separating water fountains from toilet</li><li>Separating water fountains from the ablution place</li><li>Use water-coolers near to water fountains</li><li>Attractive design of the platform of water fountains in terms of tap height being proportional for students</li><li>Designing water fountains similar to that of park in the shade</li></ul> |

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| | | |
|---|---|---|
| | low windows | |
| **Toilet** | <ul><li>Congestion in toilet because there is only one toilet in school's yard</li><li>Congestionat the entrance of toilet due to the small width of door</li><li>Long distance of toilet from the building</li><li>Adjacency of water fountains and toilet</li><li>The lack of proper air conditioning and lighting because of small and low windows</li><li>Traffic to toilet in rainy and snowy days</li></ul> | <ul><li>Decentralization of toilet in a single location</li><li>Designing wide entrance for toilet with respect to the population of students</li><li>Closeness of toilet to the building</li><li>Separating water fountains from toilet</li><li>Design toilets with good skylight and ventilation</li><li>Considering indoor path leading to toilet for being used in rainy and snowy days</li></ul> |
| **Buffet** | <ul><li>Location of buffet near the entrance of conservatory, just near the guard</li><li>Buffet is away from water fountains and toilet</li><li>Buffet is far away from the building which causes passing long path to get it</li><li>Buffet'swindow is small</li><li>The lack of space to sit around the buffet</li></ul> | <ul><li>Moving the buffet away from the entrance f conservatory and separating it from the guard</li><li>Closeaccess of buffet to water fountains and toilet</li><li>Closeaccess of the buffet to the building</li><li>Designing buffet with a larger area of sales</li><li>Buffet design combined with green spaces</li><li>Forecasting indoor spaces with tables</li></ul> |

| | | and chairs to sit students around the buffet |
|---|---|---|
| | | |

**Table 19: The Components of the yard's spaces**

| Components of the yard's spaces | Disadvantageous | Solutions |
|---|---|---|
| **Queue area** | • Lack of sufficient view for students to the place of ceremony<br>• The lack of adequate space for the required facilities to hold the morning event (platform, speakers, etc.)<br>• The lack of adequate space for the bags and belongings of students<br>• The use of land of queuearea as the sport field<br>• The lack of controlling the sunlight and cold weather in the queue area | • Designing queue area as step-like and providing better view to the place of ceremony<br>• Designing suitable space for the required facilities to hold the morning event (platform, speakers, etc.)<br>• Designing in queue area places for putting bags and belongings of students<br>• Separating queue area of the sport field<br>• Designing the queue area as controlled to prevent disturbance of the sunlight and cold weather |
| **Sports area** | • Interference of the sport area with the queue area<br>• Interaction of the sport area with the rest area of the art students at break times<br>• Adjacency of sport area to the building, creating noise and hitting of the ball to the class's windows<br>• Sports ground near the walls of the courtyard and out the ball out of the yard<br>• Lack of appropriate facilities for sports such as gymnastics, table tennis and chess<br>• Distant of sport area of the | • Separation of the sport area of the queue area<br>• Separation the queue area of the rest space of students during break times<br>• Creating a space between the sport area, the building and educational classes<br>• Distancing of sport area of the side walls of locating it on the center of the yard<br>• Providing suitable sports facilities for exercise, tennis and chess<br>• Closeness of sport area to the water fountains and toilet<br>• Providing break, coach room and storage room for sport devices |

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| | | |
|---|---|---|
| | water fountains and toilet<br>• The lack of suitable space for break room, coach room and storage<br>• Lack of roof for sport area and it exposure to sunlight and cold and thus relevant physical problems<br>• Improper flooring for sporting<br>• The lack of adequate space to sit around the sport area to watch sports | • Providing indoor sports<br>• Providing appropriate flooring like natural grass or artificial sport field<br>• Designing appropriate space to sit around the sport area to watch sports |
| **Sitting area** | • Bench are far away from water fountains, toilets and buffet<br>• Failure to select the proper materials for the structure of furniture of the yard<br>• Bench are faraway from the green space<br>• Lack of proper place for students to sit and relax<br>• Fewrows of benches with high distance from each other<br>• Location of benches next to the walls' side<br>• Placement of furniture in the sunlight<br>• Dominant view from the room of deputy and | • Closeaccess of sitting area to water fountains, toilets and buffet<br>• The use of materials with high thermal capacity such as concrete and wood to build a sitting area<br>• Designing sitting area next to green space and shady trees<br>• Providing suitable siting areas in different places of the yard<br>• Changing benches form from line form to the circular form with making front benches<br>• Moving benches away from the walls<br>• Design shaded sitting areas and using sites such as pavilions<br>• Creating indirect viewfrom the room of deputy and director to the sitting area |

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| | director to the sitting area | |
|---|---|---|

**Table 20: The Components of the yard's spaces**

| Components of the yard's spaces | Disadvantageous | Solutions |
|---|---|---|
| **Gardens and green spaces** | • Lack of proper garden in the yard and being empty when existing<br>• Garden are located on the sides and near the walls<br>• No place to sit in the garden<br>• Uniformand non-attractive form of garden | • Considering ample green space with flowers, green trees and shades<br>• Locating in green spaces in various locations of the yard<br>• Designing suitable places for students to sit around the garden<br>• Diverseand attractive design of garden and mixing it with water fountain |
| **Parking** | • No parking for cars of teachers<br>• The lack of driving entrance and interference of driving and walking traffic<br>• Occupation of the relaxing space of students by parked cars<br>• Disruptionin training hours because of the traffic of cars in the yard and the sound of a car alarm | • Considering a separate place for parkingcars of teachers<br>• Separating the entrance of walkers and drivers<br>• Locating parking away from the rest spaceof students<br>• Locating parking away from the educational spaces |
| **Yard's floor** | Uniformity of flatness of the floor<br>• Making the yard's floor of asphalt pavement and appearance of cracks over time | Height difference in the yard<br>• Using varied and colorfulfloor materials (mosaic, concrete surfaces in combination with grass) |

**RESEARCH ARTICLE**

# Effect of Economic Sanctions on Culture of Developing Countries (Case Study: Iran)

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**ABSTRACT**

Economic sanction has been regarded as one of the actions of Security Council to maintain international security and peace which is adopted based on Chapter VII of the United Nations Charter. Now it is asked whether authorities of council about exercise of economic sanctions are out of framework of international standards or not. Legal logic requires that the Security Council as a pillar of international organization and a custodian of international law adheres to international rules in its decisions, otherwise it cannot expect from collective security system to realize demands of countries with governance. United Nations General Assembly has excessively condemned unilateral coercive measures as a means to achieve political aims and has asked the industrial countries not to use their superior position as a means to exercise economic pressure with the aim of changing behavior of other countries. Our country has been regarded as one of the countries which have been invaded with economic sanctions for many years. These sanctions have been followed by numerous outcomes for people in our community, that one of these outcomes has been lied in cultural dimension which has been examined in the present research.

**Key words:** Iran, economic sanctions, cultural outcomes, international policy

## INTRODUCTION

Economy of Iran during half century ago has faced numerous crises and has involved in theoretical discussions on representation of a strategy for resolving these crises. However, Iran enjoys isolated conditions due to special political and economic conditions after revolution and unilateral and multilateral sanctions which have imposed on

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Iran by means of nuclear problems, definitely the country has been subjected to serious threats in some aspects including oil prices, imports, exchange rate and trade balance; more specifically government was accustomed to high oil prices during expansionary budget and banking years. Hence, it can say that since financial markets of Iran have no relationship with international markets, this crisis has not directly transferred to Iran. yet, there are channels highlighting that economy of Iran has been influenced of this crisis and there are also major channels of influence of this crisis on economy of our country including being influenced of reduction of oil price and exchange incomes, being influenced of imports and so on(Barzati & Izadkhasti, 2012). Sanction has been mentioned as one of the crises that Iran has faced it in recent years. In recent years, Iran has faced numerous challenges in economy due to special political and economic conditions after revolution and unilateral and multilateral sanctions. Sanction, a non-military solution, has been introduced in United Nations charter as one of the predicted ways to exercise pressure on violators of peace. This important duty has been assigned to Security Council of United Nations as the most important pillar for maintenance of international security and peace. Security Council of United Nations has duties and authorities including detection of existing facilities against international or regional peace and security and exercise of economic sanctions or adoption of military action against invader and exercise of responsibility of United Nations at strategic regions of world.  With regard to article 41 of United Nations charter which has been mentioned in Chapter VII, Security Council of United Nations can display its reaction to threat of international peace and security through invoking to sanctions. Economic sanctions have been regarded as major executive mechanisms that have been exercised to many countries by Security Council for many times (Rahnamaei & Lang, 2013). Record of exercise of these sanctions during cold war can be witnessed in two cases against Southern Rhodesia countries during 1966 and southern Africa during 1977. After cold war, Security Council of United Nations has exercised such sanctions against countries including Former Yugoslavia, Angola, Libya, Rwanda, Liberia, Haiti, Sudan and Iran. Main purpose of exercise of economic sanctions is to avoid norm-breaking by members of international community and encourage observing these principles and norms. During recent decade, Security Council has adopted a dual approach towards members who are under pressure by super-powers. For instance, United States of America which invades other countries and states for different excuses and/or threatens them with military operations and/or Israel which is the origin of many regional crises are immune from any sanctions measures. After the First World War, 183 economic sanctions have been exercised of which 140 sanctions have been exercised by United States.  In addition, nowadays economic sanction as a means to guarantee implementation of international rules and maintenance of international peace and security has necessitated. This action is accordingly legitimate from perspective of international law, unless it aims to exercise pressure and dominance on other countries in contradictory with contractual commitments of countries (Barkhordari & Farzin vash, 2013). According to viewpoint of Security Council, there is no limitation in implementation of duties from Chapter VII of charter, and detection of council is not limited to international laws. From point of view of these scholars, article 1 of this charter has been organized in a way that has assigned authority to the Security Council in implementation of Chapter VII of charter and has not limited it to international laws.

**Theoretical dimensions of sanction**

Economic sanction has been never found as the best method for resolution of international conflicts, yet it has been always the last method before invoking to coercion. Since 1990 to date, Iraq , Yugoslavia , Greece , Libya , Liberia , Haiti , front UNITA in Angola , the Revolutionary United Front, RUF, Somalia , Rwanda , Sierra Leone , Afghanistan , Taliban and al-Qaeda , Congo , Sudan , some Lebanese citizens , North Korea and Iran have been sanctioned by the UN Security Council .Yet, concerning unilateral sanctions, with regard to statement of Richard Cheney "former Secretary of Defense America", it should say that more than 70 countries with two third of world population are under influence of sanctions by U.S. Development in the concept of sovereignty and different results of sanction over the time have caused emergence of different forms of specialized  positioning about sanction(Lenza,2010). For deep understanding of sanction and representing a comprehensive definition for it and avoiding it and for identifying actual features of sanction, firstly the difference between economic sanction and trade sanction must be specified. However, trade sanction and economic sanction have the same effect from economic perspective, yet they have different effects from legal perspective. Trade sanction refers to the restrictions exercised on international trade by

national states, which these trade restrictions include defined aims in trade policy of a state, yet economic trade is considered as a means achieve aims of foreign policy. In summary, economic benefits for the country which restrict trade imply trade sanction and political benefits for the country which restrict economy imply economic sanction, clarifying the difference between economic and trade sanction. However the country which restricts trade and economic benefits might be harmed from economic perspective (Limani, 2012). According to the definition, economic sanction implies a hierarchy of planned policies to the state for restricting economic relations with another state so as to achieve their political and economic aims.

Sanctions can be exercised through unilateral and multilateral way and/or based on international resolutions. International sanction requires issuance of United Nations resolution, yet several countries agree on exercise of sanction against another country in a multilateral sanction. In a unilateral sanction, a country exercise sanctions against another country. Two recent cases do not required for issuance of Security Council resolution, providing agreement by countries on sanction. If there exists a poor chain in a multilateral sanction, the entire sanction will be weakened, because the entire strength of a string of chain depends on the strength of the poorest chain (Kibaara,2008).

**Different types of sanctions**

Accordingly, international sanctions have two general forms

1-unilateral sanctions of countries against each other

2-sanctions of UN Security Council against members

From point of view of international law, there are three different approaches at the area of unilateral sanctions by a country against another country.

According to the first approach, exercise of these sanctions are allowed based on sovereignty principle of countries. In other words, since the countries can work out freely in regulating their foreign relationships with others, thus any country has the right to stop its relationship with another country. This relationship also exists in economic problems, thus the countries can put another country under economic pressure to achieve their political aims (mwega, 2010).

In the second approach, direct economic war is permitted by one country against another country, that adverse consequences of war to the third parties should have been reduced. In this approach, the main emphasis of economic sanctions is put on target country or countries, thus these sanctions should have the least consequences on other countries (mir ebadi, 2003).

The third approach is represented with legal prohibition approach. According to this approach, the secondary as well as major sanctions are not allowed. No sanction must be exercised against countries in modern international law system, because negative consequences of sanction go beyond the positive consequences. This approach which is newer than two previous approaches has been derived from liberal classical, political and economic theories rather than international laws of liberal classical and political economists, under which the defendants of trade have freedom of action, whereby any barrier is known as damage to the world economy.

In a final investigation of the above theoretical approach and comparison with the countries' action, we deduce that countries' sanction actions against each other keep growing in most of cases, despite legal bans. The most important unilateral sanction actions in recent years include sanction of countries including Iran, Iraq and Libya by United States of America.

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Unilateral sanctions represent evident intervention in domestic and foreign affairs of country and this is contradictory to paragraph 7 of Article 2 of the Charter of the United Nations. Further, resolutions 10, 50, 9 and 47 of general assembly which ban exercise of state extraterritorial provisions are contradicted with exercise of unilateral sanctions. The second type of sanction includes sanctions by United Nations Security Council against members. With regard to the provisions of Chapter VII of the Charter, United Nations Security Council can express reaction to international peace and security provision by invoking to sanctions (Rahnamaei & Vosoghi Lang, 2013). As mentioned above, legal basis for economic sanctions in United Nations derives from article 41 of the charter, indicating the Security Council can consider the actions excluded of armed force to exercise its decisions and ask the members of United Nations to take some actions.

**Effects of economic sanctions**

A wide range of studies have not been conducted in the context of effect of economic sanctions, that the study by Hoffbauer and his colleagues is one of the bests studies in this context. His studies have almost centralized on economic sanctions of America against other countries. In these studies, effect of economic sanctions of America on export, employment and wage has been examined.  In the research model by Hoffbauer, value of trade between America and target country depends on two factors including return of their products and the distance between these two countries. In addition to these two factors, other variables such as bilateral trade are considered.  Results of research by Hoffbauer indicated that economic sanctions of America will be followed by stopping exports to sanctioned countries, under which large amounts of export earnings of America are reduced and numerous job opportunities are put aside. With regard to the research by Hoffbauer in 1990, 36% of these sanctions have worked out successfully. Hoffbauer represents an image of what has occurred in bilateral trade in his studies, e.g. America's direct trade with Iran is almost zero, yet still American commodities are imported to Iran through third countries with higher price, saying that there is the same status about America's import from Iran. In addition, goods may be smuggled into the country. Yet, whether shortage occurs in America by stopping export of goods to Iran?; this depends on type of the good which has been being exported to Iran previously and is currently exported to other countries with lower prices. Yet, indeed a shortage which occurs in America is the loss in foreign earnings from exports to this country; for instance that good can be used in America and/or expenditure of that good is used to produce another good which is consumed in domestic market (Ghadiri asl, 2008).  A large share of Iran's exports allocate to oil. However this has existed at the early years of sanction, still exporting fuels during the past decade has being developed sum of Iran's exports. Non-oil exports of Iran has been witnessed with an ascending trend to 1 billion dollars in 1987 and grown to 4.7 billion dollars in 1998. Before Islamic revolution, America has been mentioned as the most important exporting country to Iran. From point of view of Iran, oil has been the most important exporting good, and sum of non-oil export indicated a rate under 1 billion dollar, that this rate has been about 31 million dollar during 1976-1977 and 63 million dollar during 1977-1978.  However Iran's export to America was reduced after Islamic revolution, Iran enjoyed a substantial growth in export during 1992-1994. After ban of import of good from Iran to America which was issued by The President of the United States of America (POTUS) in 1987, American companies sustained on purchasing crude oil from Iran. These companies used to purchase crude oil from Iran and refined it and sent it to American, selling it to other countries. Hence, no negative impact or pressure was exercised to Iran in this context, or if there was any, it was just a little. It is believed that no loss has incurred to Iran in their earnings from exporting oil due to sanctions by America. There has not existed any sanction till 1987, after which purchasers of crude oil have not reduced however number of countries to which Iran's oil has been being exported was reduced. However Iran faced the early problems in selling a part of its oil during 1995, effect of their problems was temporary and negligent. Here, an evident result reveals in this way that effect of sanction has been little or zero in exporting interchangeable commodities, and the sanctioned country has enabled to export its commodities to another countries and earn revenue. This is in a way that rest of exporting countries has conducted their commodities to America.  Exercise of sanction on exports of all the commodities to Iran which was come to realize in 1995 largely affected economy of Iran; it is evident that Iran has no longer enabled to purchase American commodities in a direct way, yet it must say that America has been familiar to this status since the Islamic revolution.

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In response to economic sanctions, Iran started its imports through other resources, e.g. American commodities were imported through United Arabic Emirates. Indeed, before 1995, American commodities were imported through Dubai. Our estimation from harm to Iran in foreign exchanges that can be attributed to sanctions has been in range of 32.7-92.2 million dollars in 1995 and 74.3-176.3 million dollars in 1999. Yet, it should take this point into consideration that these figures associate to harm to Iran in foreign exchanges rather than economic costs (Danesh Jaffari, 2009).

**Cultural effects of sanction**

Economy of Iran is under influence of the world space, and also affects the world due to the influential power at different scientific, political and energy areas. Through expansion of economic sanction against Iran, access to a resistance pattern of economy has appeared as a necessity, that is, a pattern which is prevailed with an active approach against economic crises and found suitable to resolve barriers under critical conditions (Mir Ebadi, 2003). Resistance economy has appeared as a macro vision in economy of Iran, included of a long-term action in line with this vision. Yet, economic sanction against Iran does not date back to recent years, that the first economic sanction against Iran dates back to 30 years ago exactly at the early of Islamic revolution by united nations, resulting in blocked Iranian assets in Western banks. Later, during the past few years, sanctions have sustained on constantly under different excuses. Yet, under issuance of resolution 1929, it should take this point into consideration that sanction against Iran has been found in wider dimensions in some axes such as purchasing Iranian oil, foreign investment in economy of Iran, trade sanction, marine and aerial transport of Iran, central bank and active banks in export and import of country. The term "resistance economy" refers to this point that economic pressures by enemy forces have appeared as barriers to progress in the community that must be overcome. To understand concept of resistance economy, firstly a deep understanding from national economy, the world economy space, severity of pressure by US and other arrogant western powers to Islamic Republic of Iran. After the failures in military arena, it is for several years that US and other arrogant western powers have intended to consider some planned and purposeful actions to influence the economic environment aiming at undermining the system and putting pressure on a majority of people. In this regards, economic movement of US and other arrogant western powers must correspond to the planned environmental process. With regard to what mentioned above and the current and future status which keeps changing, resistance economy implies an active economic process to cope with any crisis. Nevertheless, it seems that we have subjected to the most severe economic pressures by western countries at current periods, for which we are required having a revolutionary approach in our lifestyle. The Supreme Leader Sayyid Ali Khamenei has put an emphasis on the necessity to access resistance economy and a majority of scholars and economists believe that origins of resistance economy have been arisen from people's economic behaviors, that we must pursue correction of economic culture to modify our economic status. In general, economic culture implies a series of beliefs, values and customs that cause the individuals within community select a special type of economic behaviors even in their production or purchase. It seems that a variety of factors and components have affects people's economic behaviors in recent decades. Widespread advertising media and arrival of luxury orientation have caused a gap between economic culture within community and features of economic behavior based on Islamic values (Keshvadi, 2009). In this regards, it seems that we have to achieve a serious revision in the type of culture governing people's economic behaviors. The Supreme Leader Sayyid Ali Khamenei mentioned many questions in his statements about lifestyle including amount of useful work, work ethic, social discipline, attention to quality in domestic productions and so forth and sought an extensive field study at this area. Under this condition, it can say that we require production of content in revolutionary lifestyle especially at economic areas. More precisely, firstly we are required to develop a complete package of Islamic lifestyle and advertise this style among the people through different media tools. Nowadays, western media with all their power keep spreading their views on lifestyle within community, and a major part of current problems are due to media and cultural invasion by enemies. Hence, we are required developing origins of Iranian-Islamic lifestyle (Zahedi, 2010). In this regard, it seems that we have neglected extensive capacities of Islamic culture at economic area in our country and Iranian people's purchase has prevailed with western inductions. In resistance economy, economic resistance against west is considered as the leading axis,

mentioned along with the concepts such as national production, increase of productivity, avoidance from economic corruption and publicizing economy and so forth.

## CONCLUSION

At economic theories, people's role as consumers of commodities is of great importance. Nevertheless, it must say that people have key duties in the issue of resistance economy. Economy of family implies how to organize and manage resources at home. Further, family businesses play a major role in economy of countries. a substantial part of existing businesses is grounded on family ownership or management, so that about half of gross domestic production is provided via these businesses. In this regards, family refers to an organization which provides production and distribution of the required commodities and each of family members have a key role in organizing economic team of family. Proper depiction of position of father, mother, children and grandparents in planning this approach is of great importance, having an effective role in developing economy of family. Unfortunately, excessive attention to luxury has been mentioned as one of serious damages in economic culture of Iranian families, having a destructive effect on quality of life of individuals and economy of a country.  Family must avoid consuming unnecessary commodities and purchase necessary commodities from Iranian producers. Lack of welcoming domestic products with improvement of quality and selection of consumer will be resolving through giving priority to domestic commodity.  Family members can assist for national economy by respecting the domestic products. This results in progress in national economy cycle and economy of family. Through changing attitude, active involvement in national production, lower consumption and more investment in resistance economy are developed. Families at different levels can play a major role in economy cycle, especially when sanction appeared more serious and pressure by U.S went beyond. Training individuals within community especially youth and children is an important issue contributing in resistance economy. In this regards, coordination between educational system and resistance economy can coordinate the young class of community with economic conditions and needs. Education system, schools, universities, and educational books play a major role in familiarizing youth and adults with issue of economic resistance and security. Besides educational system, another important factor contributing in economic resistance associates to media and advertising system. Public media, advertising system, internet, television and radio networks can expand resistance economic instructions within community and formal and informal media can have a major duty in expanding resistance economic instructions, because media system has a strong power in advertising and training economic methods. with regard to what mentioned above, here general cases of family consumption management in different cases which play a major role in resistance economy of family are mentioned; without doubt it can say that observing any Iranian family in each of cases induces the family to resistance economy.

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**RESEARCH ARTICLE**

# Investigation of Drainage Morphometric Analysis of South Beshar River Watershed, Iran

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**ABSTRACT**

In this research, Beshar water shed has been selected for detailed morphometric analysis. Morphometric analysis for parameters of stream number (Nu), stream order ($U$), bifurcation ratio ($R_b$), watershed relief ($B_b$), drainage density ($D_d$), wascarried outtodescribe thedrainage propertiesof the watershed s in the study area. The results show that among the line parameters of stream, the lag time is low that determine erodibility and flood situation in the study area. Also the results of watershed relief show that high elevation in the study cases more erodibility in the study area. According to morphometric analysis determined that in the study area watershed is more erodibility and need more management.

**Key words**:  Morphometry; Beshar watershed; DEM; GIS.

## INTRODUCTION

Various morphometricstudies show that awidely acknowledged principle of drainage watershed morphology that reflects different geomorphological processe (Horton1945; Strahler1952, 1964; Evans 1972, 1984; Chorleyetal.1984; Cox1994;Oguchi1997;Burrough and Mc Donnell 1998;Hurtrezetal.1999).

There motesensing, GIS, and GP Shave effective tools to morphometric analysis (Rao etal.2010). Using Shuttle RadarTopographic Mission (SRTM) data has given a precise,fast,and aninexpensive way for analysing hydrological systems in GIS-based evaluation (Smith andSand well 2003).The processed DEM was used for creating the stream network and ot her layers (Mesa2006;Mageshetal.2011).

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The digitalelevation model(DEM) of the area was created to deduce the morphometric parameters like drainage watershed area,drainagedensity,drainage order,relief and network diameterin GIS environment (Kumar et al., 2014).The geomorphic properties of a drainage waters hed are important for hydrological investigations involving thee valuation of ground water potential, etc.

The present study a imsatusing there motesensing and GIS technology to compute various parameters of morphometric characteristics of the Beshar River watershed.

# MATERIAL AND METHOD

**Case study**

The study area is shown in Figure 1. The data used for the case study was a Shuttle Ray Topographic Mapping (SRTM) digital elevation model (DEM) with resolution of 90 m. Thealtitude of the study area ranges from its lowest of 1548 m to the highest of 3081 m.

# METHODOLOGY

We used the fill function in the Hydrology toolset of ArcGIS software to remove the depressions to prepare sink. In the next step we made the flow direction raster. A flow direction raster shows the direction water will flow out of each cell of a filled DEM. This method used by ArcGIS, assigns a cell's flow direction to one of its eight surrounding cells that has the steepest distance weighted gradient (O'Callaghan and Mark 1984). Then we used the flow accumulation function in the ArcToolbox to extraction a flow accumulation raster which tabulates for each cell the number of cells that will flow to it. It records how many upstream cells will contribute drainage to each cell. Stream network and stream link delineation have been done in the next steps. This activity is based on a threshold accumulation value. A higher threshold value will result in a less dense stream network and fewer sub basins than a lower threshold value. In the last stage, the rivers are ordered by Strahler method ordering and transformed to vector layer for further analysis. Morphometric parameters that analysis in the study area are shown in Table 1.

# RESULTS

**Stream order**

Automatic extraction of Streams made through ASTER data (Figure 2). Also SRTMDE Mis used to prepare slope,aspectand contour maps.Based on the stream order, the Beshar watershed is classified as three order watershed to interpret the morphodynamic parameters as showed in Table1(Mesa2006).

In the study area,ranking of streams has beend one based on the Strahler method(1964).The stream orders are classified upto six thorders in the Beshar watershed (Figure 2)(Table 2).

**Slope**

Aslo pemap of the study area is calculated based on ASTER DEM data using the spatial analysis toolinARCGIS-10.2.The degree of slope in Beshar watershed varies from0 to 54(Figure3). Higher slopedegreeresultsinrapidrunoff and increase derosion rate with less ground water recharge potential.

**Relative relief**

The highestrelativere lief is calculated as3081m,while the lowest valueis recorded as 1548m where is shown in Figure 4.

**Stream number**

During computation it is identified that the number of streams graduallydecreasesasthestreamorderincreases; the variation in stream order and size of tributary watersheds is largely depends on physiographical,geomorphological and geological condition of theregion.262stream line including Beshar River is recognized in the whole watershed (Table 3).

**Stream length**

The stream length is a measure of the hydrological properties of the bedrock and the drainageextent.Where verthebedrock and formation is permeable, only a small number of relatively longer streams are formed in awell-drained watershed, alarge number of streams of smaller length are developed where the bedrocks and formations arelesspermeable (Horton1945). There sult of stream length is shown inTable4.

**Stream length ratio**

The stream length ratio between the streams of different orders of the Beshar watershed showsachangeineachsub-watershed(Table 5).

**Bifurcation ratio**

In the Beshar watershed, the higher values of Bifurcation ratio indicate a strong structural control in the drainagepattern where as the lower values indicate that the sub-waters hed sareless affected by structural disturbances (Chopraetal.2005).The Bifurcation ratio for the Beshar watershed varies from1.19to4.16 (Table6).

**Relief ratio**

Low value of relief ratios is mainly because the persistent basement rocks of the watershed and low degree of slope. Mean relief ratio of each sub-watershed of Beshar watershed is shown in the Table 7.

**Drainage density**

The drainage density of the Beshar watershed is shown in the Table 8. Low drainage density leads to coarse drainage texture while high drainage density leads to fine drainage texture, high runoff and erosion potential of the watershed area. (Strahler 1964).

## CONCLUSION

In the present paper, morphometric analysis of the Beshar River watershed, based on several drainage parameters using remote sensing satellite data and latest GIS tools for drainage analysis, has been delineated. Morphometric analysis for line parameters of stream, watershed relief and geomorphology were carried out to describe the drainage properties in the study area. The results show that among the line parameters of stream, the lag time is low that

determine erodibility and flood situation in the study area. Also the results of watershed relief show that high elevation in the study cases more erodibility in the study area. According to morphometric analysis determined that in the study area watershed is more erodibility and need more management.

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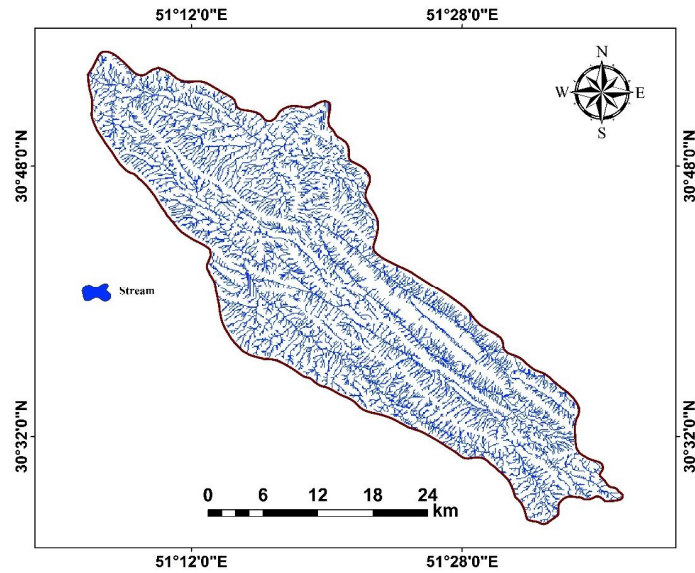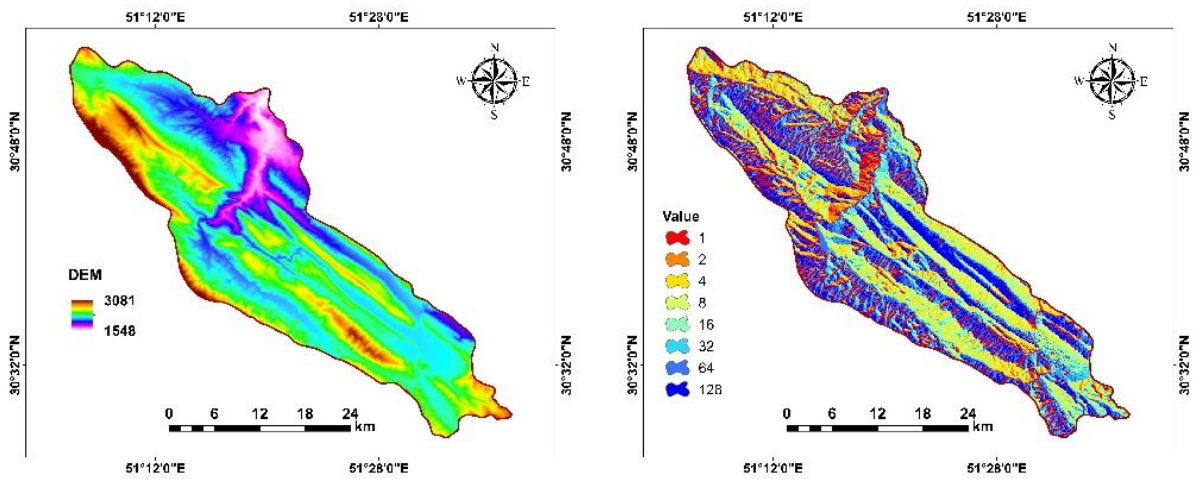
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**Figure1: position of the study area**

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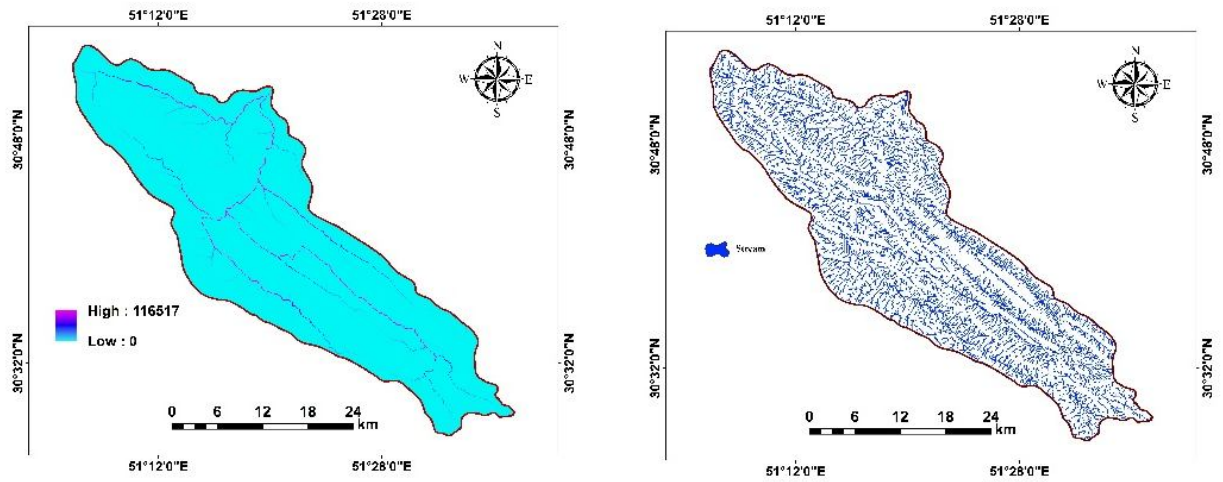


**Figure2: Automatic extraction of Streams by DEM data**



(a)                                                                                     (b)
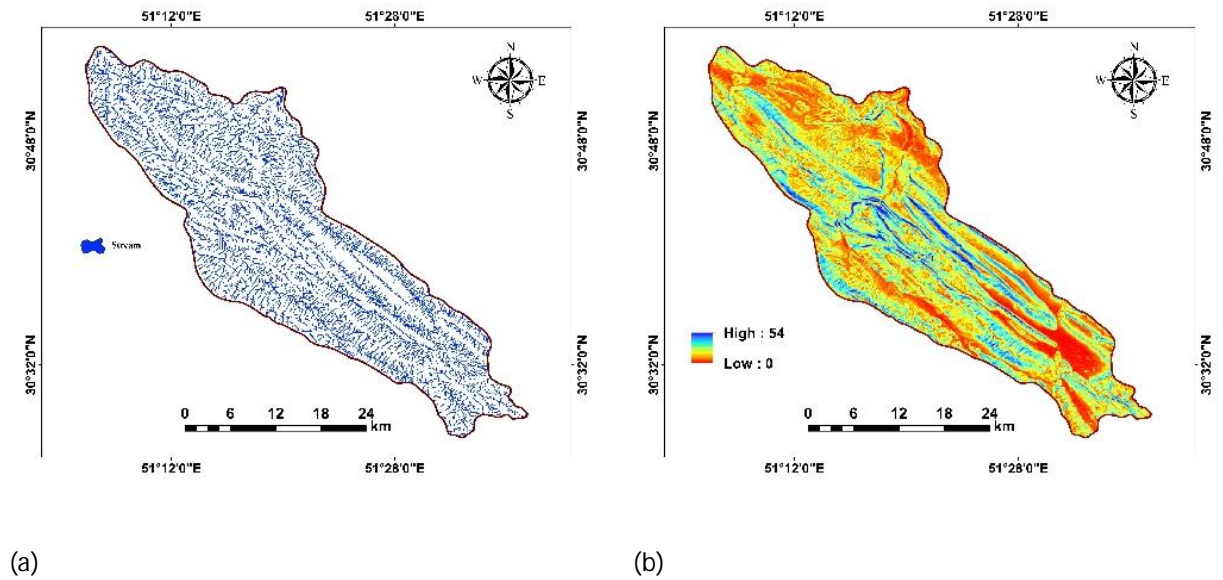
**Alizadeh *et al.***
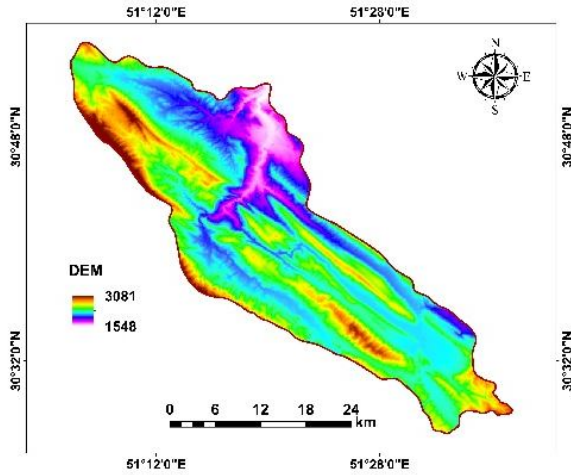


(c)

**Figure3: stream order (a), slopemap (b), reliefmap(c)ofBeshar Riverwatershed**

**Table 1 Linear relief and areal morphometric parameters used for Beshar river watershed (Strahler (1964), Horton (1945))**

| Morphometric parameters | Formula | Description |
|---|---|---|
| Stream order ($U$) | Hierarchicalank | - |
| Stream length ($L_u$) | Length of the stream | - |
| Mean stream length ($L_{sm}$) | $L_{sm} = L_u/N_u$ | $N_u$ =Total number of stream segments of order $u$ |
| Stream length ratio ($R_L$) | $R_L=L_u/L_{(u-1)}$ | $L_{(u-1)}$=Totalstream lengthofthe nextlower order |
| Bifurcation ratio ($R_b$) | $R_b=N_u/N_{(u+1)}$ | $N_{(u+1)}$=Numberofsegments ofnexthigherorder |
| Relief ratio ($R_h$) | $R_h = H/L$ | H= Total relief (relative relief) of the watershed in km; $L_b$ =Watershed length |
| Drainage density ($D$) | $D=L_u/A$ | A=Watershed area(km$^2$) |

**Table2 Sub-watershedareaofBeshar watershed**

| Sub-watershed | Stream order | Area (km$^2$) |
|---|---|---|
| 1 | VI | 262 |

**Table3 Streamnumberofdifferentsub-watershedofBeshar watershed**

| sub-watershed | Number | | | | | |
|---|---|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** | **V** | **VI** |
| 1 | 146 | 64 | 28 | 12 | 10 | 2 |

**Table4 Streamlengthofsub-watershedofBeshar watershed**

| sub-watershed | Length (m) | | | | | |
|---|---|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** | **V** | **VI** |
| 1 | 67.53 | 19.17 | 8.19 | 3.67 | 1.58 | 1.33 |

**Table5 Streamlengthratioofsub-watershedofBeshar watershed**

| sub-watershed | II/I | III/II | IV/III | V/VI | VI/V | VII/VI |
|---|---|---|---|---|---|---|
| 1 | 0.28 | 0.43 | 0.45 | 0.43 | 0.84 | 0.24 |

**Table 6 Bifurcation ratio of sub-watershed of Beshar watershed**

| sub-watershed | I/II | II/III | III/IV | IV/V | V/VI | VI/VII |
|---|---|---|---|---|---|---|
| 1 | 3.52 | 2.34 | 2.23 | 2.32 | 1.19 | 4.16 |

**Table 7 Relief Ratio of sub-watershed of Beshar watershed**

| sub-watershed | Min elevation | Max elevation | Relief | Relief Ratio |
|---|---|---|---|---|
| 1 | 1548 | 3081 | 1533 | 15.06 |

**Table 8 Drainage density of sub-watersheds of Beshar watershed**

| sub-watershed | Total lenght | Area (km²) | Drainage density |
|---|---|---|---|
| 1 | 101.79 | 1440.39 | 0.07 |

**RESEARCH ARTICLE**

# Simulated Annealing Algorithm for Minimizing Total Resource Tardiness Penalty Costs in the RCPSP

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**ABSTRACT**

In this paper, we study a resource-constrained project scheduling problem in which the objective is minimizing total Resource Tardiness Penalty Costs. We assume renewable resources that are limited in number, are restricted to very expensive equipment and machines, therefore they are rented and used in other projects, and are not available in all project periods. In other words, there is a predefined ready date as well as a due date for each renewable resource type, so that no resource is used before its ready date. However, resources are permitted to be used after their due date by paying penalty costs depending on the resource type. The objective is to minimize the costs of renewable resource usages. We formulate and mathematically modeled this problem as mixed integer programming model. Since our problem is NP-hard, metaheuristic methods are practical approaches. We consider a project network and then solve the model with exact procedure and Simulated Annealing, Genetic and Tabu Search algorithms. Also, we present a Simulated Annealing Algorithm to solve the instances with large size of this problem. In order to examine the performance of this algorithm, data derived from the related literature were used, and their answers were compared with Genetic and Tabu Search algorithms. Findings show that in average, quality of Simulated Annealingresults was better than those of the Genetic and Tabu Search algorithms. In addition, we use relaxation method to validatethe algorithm.

**Key words:** Resource-constrained project scheduling, resource tardiness penalty costs, metaheuristic algorithms.

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# INTRODUCTION

The Resource-Constrained Project-Scheduling Problem (RCPSP) is one of the well-known problems in the areas of project scheduling and combinatorial optimization. RCPSP includes a project that has a number of specific activities with certain durations. RCPSP contains two constraints, precedence constraints in which technical precedence relation between activities is finish to start, and resource constraints. The objective here is to minimize project makespan. In RCPSP, While an activity is being executed, preemption is not permitted, i.e., once started, an activity should be continued until it is finished. It is shown byBlazewicz, Lenstra, and Rinnooy-Kan [1] that the RCPSP, as a job-shop generalization, is NP-hard in the strong sense. Several solution procedures have been presented in the literature. They can be classified into three categories: exact methods such as works of Demeulemeester and Herroelen [2], Mingozi et al. [3], and Patterson et al. [4], which mainly make use of various branch-and-bound procedures; heuristic methods based on the serial and the parallel schedule generation schemes proposed byBoctor [5], Kolisch, and Drexl [6]. Finally, metaheuristic methods based on Tabu search introduced byBaar et al. [7], Nonobe and Ibaraki [8], simulated annealing developed byBouleimen and Lecocq [9], Cho and Kim [10], and genetic algorithms studied byAlcaraz and Maroto [11], Alcaraz et al. [12], Hartmann [13], Mendes et al. [14], and Valls et al. [15]. Surveys on several other solution procedures can be found in Demeulemeester and Herroelen [16]. The RCPSP under minimization of total costs of resources is an applicable problem and a modified version of the RCPSP in which all assumptions and constraints of the RCPSP are maintained, but the objective function is different. Moreover, several exact, heuristic and metaheuristic algorithms are proposed for scheduling problems with objective function related to tardiness. Nadjafi and Shadrokh [17] developed a Branch-and-bound algorithm for the weighted earliness–tardiness project scheduling problem using generalized precedence relations. Liaw, Lin, Cheng, and Chen [18] developed a Branch-and-bound algorithm for scheduling unrelated parallel machines for minimizing total weighted tardiness. Essafi, Yazid, and Dauzère-Pérès [19] presented a genetic local search algorithm for minimizing total weighted tardiness in the job-shop scheduling problem. Bilge, Kiraç, Kurtulan, and Pekgün [20] developed a tabu search algorithm for the parallel machine total tardiness problem. In addition, Bilge, Kurtulan, and Kiraç [21] presented a tabu search algorithm for the single machine total weighted tardiness problem. Bianco, Dell'Olmo, and Speranza [22] referred to resources that can be assigned to only one activity at a time in dedicated form.However, in this article, we assume that there exist only a few renewable resources such as very expert human resources with high skill levels, particular types of cranes, and tunnel boring machines that have to be leased from third party providers. Considering that these limited renewable resources are employed in other projects, there is a dictated ready-date as well as a due-date for each of them, such that no resource can be accessible before its ready-date; however, these resources are allowed to be used after their due dates by paying penalty cost, depending on the resource type. Ranjbar et al. [23] studied this problem with single mode for each activity, and availability of one unit for each type of renewable resource, which they used the exact method of Branch-and-boundin order to solve the problem. The problem we studied here is a generalization of the problem introduced by Ranjbar et al., with the difference that ,the assumption that only one unit of each resource type is available, and no activity needs more than one resource for execution has been removed .In addition we used metaheuristic algorithm to solve the problem.since our problem with this profile is unique and be raised for the first time and the optimal solution could not be found in literature review, so we used validation approaches.

### PROBLEM MODELING AND FORMULATIONS

In this article, we introduce a resource-constrained project-scheduling problem with finish-to-start precedence relations among project activities, considering renewable resource tardiness penalty costs. For each project, n activities and R renewable resources are given. $R_k$ is the availability of each renewable resource. The duration of an activity i is given as $d_i$. Activity j requires $r_{jk}$ units of renewable resource k. Our model is presented using an activity-on-node (AON) network. Thus, there are two dummy activities, first activity and the last activity (0 and n+1), which denote start and end of the project, respectively. The dummy start and end activities have zero duration and zero

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resource consumption. It should be noted that for each renewable resource $k,\rho_k,\delta_k$ and $p_k$ show the ready date, due date, and tardiness penalty cost of this renewable resource, respectively. In order to embed the resource release dates in the network, one dummy node corresponding to each resource $k$, $k=1,\ldots,R$, is added to the project network. This node displays an activity with duration $\rho_k$ with no resource requirements, which is a direct successor of the start dummy activity and direct predecessor of every activity $i \in N_k$ where $N_k$ is a set of activities that need a number of renewable resources of $k \in R$ type for execution. Each type of limited renewable resource is rented for a fixed period, starting from its ready time, and ending with its due date, and is not available before its ready time, but can be used after its due-date provided a tardiness penalty cost is paid.All activities are ready at the beginning of the project, and no preemption is permitted. We define the problem parameters as follows:

$n$: Number of project activities
$R$: Number of renewable resources
$R_k$: Renewable resource $k$ availability
$\rho_k$: Ready time of renewable resource $k$
$\delta_k$: Due date of renewable resource $k$
$P_k$: Tardiness penalty cost of renewable resource $k$ for each period
$Pr_j$: Set of predecessors of activity $j$
$d_j$: Duration of activity $j$
$r_{jk}$: Renewable resource $k$ requirement for executing activity $j$

$T_k$: Is the renewable resource $k$ tardiness, determined by $T_k=\max\{CP_k-\delta_k, 0\}$, where $CP_k$ is the release time of resource $k$ in the project and equal to $CP_k=\max\{f_i\}i \in N_k$.

(Earliest) finish time that is shown with $f_i$, $(f_i=s_i+d_i)$, where $s_i$ is an integer and shows the start time of activity i. The mixed integer-programming model for this problem can be formulated as follows:

$$\min z = \sum_{k=1}^{R} P_k T_k \qquad \qquad 1)$$

s.t.

$$CP_k \geq S_i+d_i i \in N_k \quad k=1,2,\ldots,R \qquad 2)$$

$$T_k \geq CP_k-\delta_k \quad k=1,2,\ldots,R \qquad 3)$$

$$T_k \geq 0 \quad k=1,2,\ldots,R \qquad 4)$$

$$S_j-S_i \geq d_i \quad j=1,2,\ldots,n \; i \in Pr_j \qquad 5)$$

$$\sum_{\boxed{?} \in \boxed{?}(\boxed{?})} \boxed{?}_{\boxed{?}} \leq \boxed{?}_{\boxed{?}} \quad \boxed{?}= 1,2,\ldots,\boxed{?} \qquad 6)$$

$$S_i \geq \rho_k i \in N_k \quad k=1,2,\ldots,R \qquad 7)$$

$$S_i, CP_k, T_k \in \mathbb{N}^+ \quad \text{for } i=0,1,\ldots,n+1 \qquad 8)$$

In the above model, objective function (1) represents the minimization of the total weighted resource tardiness penalty costs. It should be noted that as the cost of renting for each renewable resource is fixed, it does not need incorporation in the objective function. Constraint (2) shows that the release time of each resource is not less than the

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finish time of each activity, which requires that resource. Constraint sets (3) and (4) ensure that $T_k$ is equal to max $\{CP_k-\delta_k, 0\}$. Constraint (5) is the precedence constraint implying that start time of activity j must be after all its predecessors are finished. Constraint (6) is the renewable resource constraint, where A(t) is the set containing in-progress activities at time t. Constraint (7) makes the starting times of all activities greater than or equal to the release dates of their corresponding resources. Constraint (8) ensures that variables $S_i, CP_k$ and $T_k$ are non-negative integers. In order to validate the proposed Simulated Annealing solution, we considered a small network as a case example. Table number one shows the resource information which in relation to our example with n = 7 real activities, m = 2 resources and the corresponding graph is depicted in Fig. 1.In this figure, the number shown above each node indicates activity duration and the number (s) below indicate the resources required for activity execution. The nodes labeled $\alpha$ and $\beta$ correspond to ready times of resource 1 and 2, respectively. We solved this example with exact procedure, Simulated Annealing, Tabu Search and Genetic algorithms. The results are shown in Table 2.

## Computational Study

The aim of this section is to evaluate the performance of the proposed approach by comparing it with Simulated Annealing. The performance is appraised according to the objective function value quality. We used MATLAB (2009)on a PC with Windows 7, Intel (R) Core (TM) 2 with 2.53 GHz processor, and 8 GB of RAM.

### Test problem

We used the sample problems in the library of PSPLIB [30] and selected two sets of project scheduling problems (i.e. j30 and j60). These data do not have some of our model parameters such as costs of non-renewable resources, penalty cost of renewable resources and the ready time of renewable resources. Hence, we applied discrete uniform distribution to select the parameters. The unit penalty costs of renewable resource tardiness were randomly chosen from discrete uniform distribution (10, 30). The ready times of renewable resources were randomly generated from discrete uniform distribution (0, 15) and the renewable resources due dates were randomly picked from discrete uniform distribution:

$$\sum_{m=1}^{?} ?/5, \quad \sum_{m=1}^{?} ?/3$$

### Performance of the Proposed Algorithm

In order to evaluate performance of the SA algorithm, the algorithm was implemented for the test data. Obtained results were compared with results of the Genetic and Tabu Search algorithms. Comparison results are given in tables (3) and (4), which are presented for j30 and j60, respectively. The first column of the table shows the Data Name. The ending section of the Data Name, which is in number form, represents the number of random parameters which were randomly generatedusing the aforementioned method. In fact, for each problem, parameters are randomly produced three-times. Columns 2 and 3 show the name of the metaheuristic algorithm. Each of these columns comprises four other columns, in which the first column shows the minimum result obtained from five repetitions. Columns 2, 3, and 4 represent average, maximum, and standard deviation, respectively. The last row of this table displays result averages for simpler and better comparison. Fig. (2) and Fig. (3)represent performance difference between the three algorithms forj30 and j60 respectively. The vertical axis showsthe objective function value and the horizontal axis displaysthe data. In the next section, we will provide descriptions of obtained results.

## DISCUSSION

Table 3 shows that the average mean of the results obtained by the Simulated Annealing algorithm for j30 equals 836.75, which is better than the results gained by TabuSearch and Genetic algorithms, which are equal to 846.63 and 838.47 respectively. This result also holds true for the average minimum and average maximum. Table 4 shows that the average mean of the results obtained by the Simulated Annealing algorithm for j60, equals to 1020.85, which is better than the obtained results by the other two algorithms, which are equal to 1073.01 and 1068.59.This finding also holds true for the average minimum and average maximum.In solving the larger size of problem instances, the Simulated Annealing algorithmgains better answers than the other two meta-heuristic algorithms. Another important criterion for performance evaluation is standard deviation. As shown in table 3, the standard deviation average of the answers obtained by Simulated Annealing equals to zero, which is less than the other two meta-heuristic algorithms. This result also holds true for j60. Therefore, the answers of the Simulated Annealing is less scattered than the answers of TabuSearch and Genetic algorithms. As seen in Figure 2 and Figure 3, it is clear that the Simulated Annealing is more efficient than the other two algorithms in J30 and J60 standard test problems.In these figures, as the gap between Simulated Annealing and other methods gets larger, indicates that the Simulated Annealing is more reliable than TabuSearch and Genetic algorithms. Since our problem is NP-HARD, we relaxed the resource constraint to achieve better validation for the solution method. Then, we solved the problem with both exact procedure and metaheuristic algorithms. As shown in tables 5 and 6, all the answers are similar. In fact, the results of the resource constraint relaxation are the lower bound of the problem.

## CONCLUSION

In this paper, we studied the problem of minimizing total resource tardiness penalty costs in the resource constrained project-scheduling problem with different metaheuristic algorithms. We formulated and mathematically modeled this problem as a mixed integer programming model. At first, we considered a small network to validatethe proposed metaheuristic algorithm and subsequently solved it with exact procedure and three different metaheuristic algorithms. The results were similar for all four algorithms. Then we used the Simulated Annealing algorithm to solve the proposed project scheduling problem. In order to endorse the performance of the proposed algorithm in medium and larger scales, the procedure was applied to the various test problems available in the literature and compared with the Tabu Search and Genetic algorithm. Computational results showed that this algorithm provided competitive results in comparison with the other two algorithms. We used relaxation method to validate further the solution methodand we obtained the objective function values using exact and metaheuristic algorithms for J30and J60 problem instances.The results displayed that all the objective function values were identical. Finally, it should be noted that the findings of this paper indicate that the proposed solution technique are efficient enough to tackle this type of project scheduling problem.

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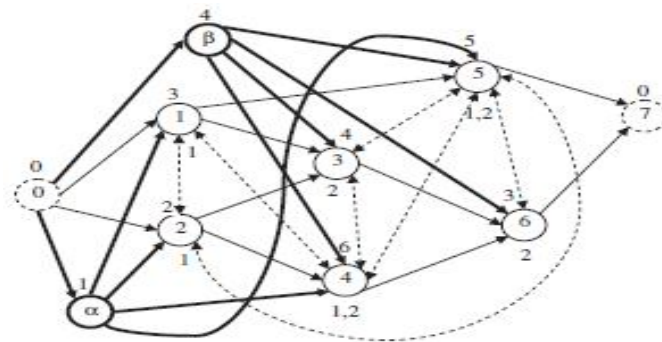
**Figure 1.Network of the example project**



**Figure 2.Comparison between performance of SA, TS and GA for J30**

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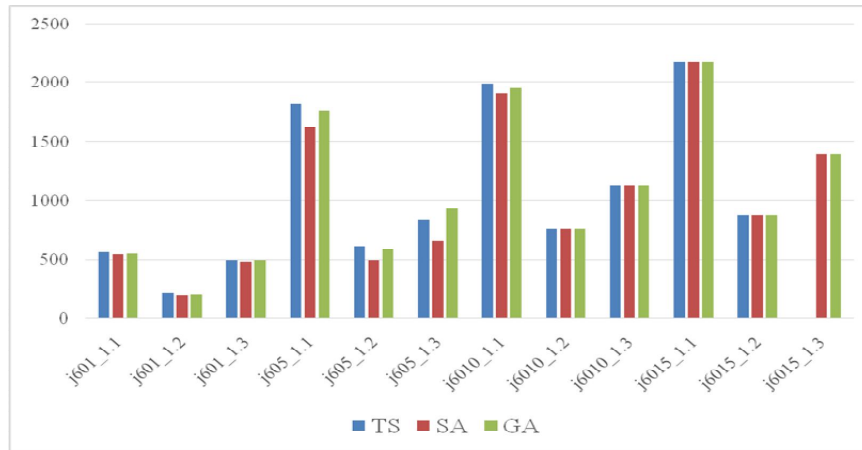


**Figure 3.Comparison between performance of SA, TS and GA for J60**

**Table 1. Resource information of the example project.**

|  | Ready Date | Due Date | Penalty Cost | $N_k$ |
|---|---|---|---|---|
| Resource 1 | 2 | 11 | 14 | {1,2,4,6} |
| Resource 2 | 3 | 10 | 11 | {3,5,7} |

**Table 2.Comparison between performance of exact and metaheuristic algorithms for the example problem**

| Exact Solution | SA | TS | GA |
|---|---|---|---|
| 14 | 14 | 14 | 14 |

**Table 3.Comparison between performance of SA, TS and GA for J30**

| Name | TS | | | | SA | | | | GA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Min | Avg | Max | SDev | Min | Avg | Max | SDev | Min | Avg | Max | SDev |
| j301_1.1 | 563 | 563 | 563 | 0 | 563 | 563 | 563 | 0 | 563 | 563 | 563 | 0 |
| j301_1.2 | 515 | 515 | 515 | 0 | 515 | 515 | 515 | 0 | 515 | 515 | 515 | 0 |
| j301_1.3 | 289 | 289 | 289 | 0 | 289 | 289 | 289 | 0 | 289 | 289 | 289 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| j305_2.1 | 1150 | 1178.53 | 1244 | 24.53 | 1150 | 1150 | 1150 | 0 | 1150 | 1157.08 | 1235 | 24.53 |
| j305_2.2 | 1234 | 1245.63 | 1275 | 8.64 | 1234 | 1234 | 1234 | 0 | 1234 | 1239.75 | 1257 | 10.40 |
| j305_2.3 | 1097 | 1112.42 | 1143 | 15.63 | 1034 | 1034 | 1034 | 0 | 1034 | 1041.75 | 1127 | 26.84 |
| j3010_1.1 | 733 | 733 | 733 | 0 | 733 | 733 | 733 | 0 | 733 | 733 | 733 | 0 |
| j3010_1.2 | 821 | 821 | 821 | 0 | 821 | 821 | 821 | 0 | 821 | 821 | 821 | 0 |
| j3010_1.3 | 538 | 538 | 538 | 0 | 538 | 538 | 538 | 0 | 538 | 538 | 538 | 0 |
| j3015_1.1 | 1109 | 1109 | 1109 | 0 | 1109 | 1109 | 1109 | 0 | 1109 | 1109 | 1109 | 0 |
| j3015_1.2 | 1117 | 1117 | 1117 | 0 | 1117 | 1117 | 1117 | 0 | 1117 | 1117 | 1117 | 0 |
| j3015_1.3 | 938 | 938 | 938 | 0 | 938 | 938 | 938 | 0 | 938 | 938 | 938 | 0 |
| Average | 842 | 846.63 | 857.08 | 4.07 | 836.75 | 836.75 | 836.75 | 0 | 836.75 | 838.47 | 853.5 | 5.15 |

**Table 4.Comparison between performance of SA, TS and GA for J60**

| Name | TS | | | | SA | | | | GA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Avg | Max | SDev | Min | Avg | Max | SDev | Min | Avg | Max | SDev |
| j601_1.1 | 547 | 564.43 | 587 | 12.95 | 547 | 547 | 547 | 0 | 547 | 554.5 | 572 | 12.07 |
| j601_1.2 | 204 | 212.52 | 276 | 23.63 | 195 | 195 | 195 | 0 | 195 | 198.7 | 210 | 6.32 |
| j601_1.3 | 486 | 498.52 | 524.69 | 18.35 | 486 | 486 | 486 | 0 | 486 | 495.2 | 532 | 19.39 |
| j605_1.1 | 1736 | 1826.46 | 2016 | 27.42 | 1616 | 1621.75 | 1639 | 10.40 | 1639 | 1765.30 | 1872 | 21.27 |
| j605_1.2 | 578 | 615.53 | 626 | 21.63 | 489 | 500.41 | 578 | 20.31 | 578 | 589.6 | 606 | 17.71 |
| j605_1.3 | 793 | 838.42 | 1153 | 42.74 | 649 | 658.83 | 767 | 34.06 | 837 | 934.53 | 1023 | 19.38 |
| j6010_1.1 | 1953 | 1989.30 | 2035 | 21.53 | 1903 | 1910.32 | 1926 | 21.42 | 1926 | 1954.3 | 1995 | 7.23 |
| j6010_1.2 | 758 | 758 | 758 | 0 | 758 | 758 | 758 | 0 | 758 | 758 | 758 | 0 |
| j6010_1.3 | 1133 | 1133 | 1133 | 0 | 1133 | 1133 | 1133 | 0 | 1133 | 1133 | 1133 | 0 |
| j6015_1.1 | 2177 | 2177 | 2177 | 0 | 2177 | 2177 | 2177 | 0 | 2177 | 2177 | 2177 | 0 |
| j6015_1.2 | 873 | 873 | 873 | 0 | 873 | 873 | 873 | 0 | 873 | 873 | 873 | 0 |
| j6015_1.3 | 1390 | 1390 | 1390 | 0 | 1390 | 1390 | 1390 | 0 | 1390 | 1390 | 1390 | 0 |
| Average | 1052.33 | 1073.01 | 1129.06 | 14.02 | 1018 | 1020.85 | 1039.08 | 7.18 | 1044.92 | 1068.59 | 1095.08 | 8.61 |

**Table 5.Comparison between performance of exact and metaheuristic algorithms in relaxed state for J30**

| Name | Relax Solution (exact) | TS | | | | SA | | | | GA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Avg | Max | SDev | Min | Avg | Max | SDev | Min | Avg | Max | SDev |
| j301_1.1 | 297 | 297 | 297 | 297 | 0 | 297 | 297 | 297 | 0 | 297 | 297 | 297 | 0 |
| j301_1.2 | 215 | 215 | 215 | 215 | 0 | 215 | 215 | 215 | 0 | 215 | 215 | 215 | 0 |
| j301_1.3 | 57 | 57 | 57 | 57 | 0 | 57 | 57 | 57 | 0 | 57 | 57 | 57 | 0 |
| j305_2.1 | 400 | 400 | 400 | 400 | 0 | 400 | 400 | 400 | 0 | 400 | 400 | 400 | 0 |
| j305_2.2 | 480 | 480 | 480 | 480 | 0 | 480 | 480 | 480 | 0 | 480 | 480 | 480 | 0 |
| j305_2.3 | 181 | 181 | 181 | 181 | 0 | 181 | 181 | 181 | 0 | 181 | 181 | 181 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| j3010_1.1 | 666 | 666 | 666 | 666 | 0 | 666 | 666 | 666 | 0 | 666 | 666 | 666 | 0 |
| j3010_1.2 | 726 | 726 | 726 | 726 | 0 | 726 | 726 | 726 | 0 | 726 | 726 | 726 | 0 |
| j3010_1.3 | 445 | 445 | 445 | 445 | 0 | 445 | 445 | 445 | 0 | 445 | 445 | 445 | 0 |
| j3015_1.1 | 1109 | 1109 | 1109 | 1109 | 0 | 1109 | 1109 | 1109 | 0 | 1109 | 1109 | 1109 | 0 |
| j3015_1.2 | 1117 | 1117 | 1117 | 1117 | 0 | 1117 | 1117 | 1117 | 0 | 1117 | 1117 | 1117 | 0 |
| j3015_1.3 | 938 | 938 | 938 | 938 | 0 | 938 | 938 | 938 | 0 | 938 | 938 | 938 | 0 |
| Average | 552.58 | 552.58 | 552.58 | 552.58 | 0 | 552.58 | 552.58 | 552.58 | 0 | 552.58 | 552.58 | 552.58 | 0 |

**Table 6.Comparison between performance of exact and metaheuristic algorithms in relaxedstate for J60**

| Name | Relax Solution (exact) | TS | | | | SA | | | | GA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Avg | Max | SDev | Min | Avg | Max | SDev | Min | Avg | Max | SDev |
| j601_1.1 | 433 | 433 | 433 | 433 | 0 | 433 | 433 | 433 | 0 | 433 | 433 | 433 | 0 |
| j601_1.2 | 171 | 171 | 171 | 171 | 0 | 171 | 171 | 171 | 0 | 171 | 171 | 171 | 0 |
| j601_1.3 | 486 | 486 | 486 | 486 | 0 | 486 | 486 | 486 | 0 | 486 | 486 | 486 | 0 |
| j605_1.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| j605_1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| j605_1.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| j6010_1.1 | 1903 | 1903 | 1903 | 1903 | 0 | 1903 | 1903 | 1903 | 0 | 1903 | 1903 | 1903 | 0 |
| j6010_1.2 | 736 | 736 | 736 | 736 | 0 | 736 | 736 | 736 | 0 | 736 | 736 | 736 | 0 |
| j6010_1.3 | 1133 | 1133 | 1133 | 1133 | 0 | 1133 | 1133 | 1133 | 0 | 1133 | 1133 | 1133 | 0 |
| j6015_1.1 | 2177 | 2177 | 2177 | 2177 | 0 | 2177 | 2177 | 2177 | 0 | 2177 | 2177 | 2177 | 0 |
| j6015_1.2 | 873 | 873 | 873 | 873 | 0 | 873 | 873 | 873 | 0 | 873 | 873 | 873 | 0 |
| j6015_1.3 | 1390 | 1390 | 1390 | 1390 | 0 | 1390 | 1390 | 1390 | 0 | 1390 | 1390 | 1390 | 0 |
| Average | 775.17 | 775.17 | 775.17 | 775.17 | 0 | 775.17 | 775.17 | 775.17 | 0 | 775.17 | 775.17 | 775.17 | 0 |

**RESEARCH ARTICLE**

# Zinc Concentration in Soybean Organs Affected by Zn, Fe and Mn Fertilizations

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**ABSTRACT**

In order to study of zinc concentration in soybean (Glycine max L.) organs affected by Zn, Fe and Mn fertilizations, two field experiments were conducted at the research field of the Islamic Azad University of Kermanshah, Iran in 2010 and 2011 growing seasons. Three rates of zinc (0, 20 and 40 kg/ha from $ZnSO_4$ source), iron (0, 25 and 50 kg/ha from $FeSO_4$ source) and manganese (0, 20 and 40 kg/ha from $MnSO_4$ source) were used. At sampling times, five plants selected randomly, zinc concentration was determined by Atomic Absorption Spectrometry, and then ratios of this element in soybean organs were calculated. Based on results obtained, with increases soybean old from onset flowering to final maturity, Zn concentration declined in stem and leaves. Also, Zn content in leaves was more than the stem in all the growth stages. [Zn]leaf/[Zn]stem ratio was increased with zinc, iron and manganese applications, So that the ratio of [Zn]leaf to [Zn]stem was more than 6.5 times. In our experiment, [Zn]seed/[Zn]stem, [Zn]seed/[Zn]leaf and [Zn]seed/[Zn]pod ratios were recorded more than 9, 1.4 and 1.2 times, respectively.

**Key words**: growth stages, micronutrient, seed, soybean, zinc transport.

## INTRODUCTION

Zinc deficiency in the soil is a major problem for agricultural production. It is estimated that about half of the cultivated soils in the world contains reduced amounts of bioavailable zinc. Zn uptake is reduced as a result of zinc

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deficiency in the soil, resulting in reduces in crops yield and quality (Henriques et al., 2012). The uptake of zinc happens actively through root membrane carriers. This element plays an important role in metabolism of nitrogen, stabilizes cytoplasmic ribosomes, catalyzes oxidation processes, synthesis of amino acid tryptophan, involve in the protein and carbohydrate metabolism, plants flowering and fruit set, increasing plant resistance to fungal disease and expanding plants roots (Fageria, 2009; Sadeghzadeh, 2013). Excess amount of this metal can exert toxicity to plant cells, so that the range between deficient and toxic levels of zinc is narrow. In comparison with total zinc in the soil, zinc concentration in the soil solution is usually small. Zinc in the soil is simply complexed with clay particles and organic matter, so in this form will not be absorbed. Soluble forms of zinc are very available for plant roots. Zinc has a high solubility and mobility in slightly acid soils (Kabata-Pendias, 2011). Cakmak, (2008) and Cakmak, (2011) reported that solubility of zinc in the soil is determined by amount of soil organic matter, pH, water content in the soil and microorganisms. In addition to that, other macro and micronutrients can affect on zinc absorption by roots and transport to shoots. Despite all the research done, there is little knowledge about the zinc homeostasis in plant organs. In this work, the authors aim to evaluate of zinc transport in different organs and various growth stages of soybean plant under the influence of zinc, iron and manganese fertilization.

## MATERIALS AND METHODS

Zinc is essential element for plant growth and development; therefore two field experiments were conducted at the research field of the Islamic Azad University of Kermanshah province, Iran (34023' N, 4708' E; 1351 m elevation) in 2010 and 2011. Williams cultivar [Glycine max (maturity group III), supplied by the oilseed company of the Kermanshah Agricultural Administration, Iran], was selected as the experimental material. The experimental design was a 3×3×3 factorial experiment based on Randomized Complete Block with three replicates. Before planting, Soil samples were collected from experimental area at 0-30 cm depth for soil analyses. The texture of the soil based on silty clay with pH 7.6, total organic matter 2.3%, electrical conductivity (ECe) 0.61 dsm$^{-1}$, total nitrogen 0.18%, available phosphorus 9.9 mgkg$^{-1}$, available potassium 563 mgkg$^{-1}$, zinc 0.71, iron 6.2 and manganese 4.3 mg per kg soil for year of 2010 and pH 7.4, total organic matter 2.1%, electrical conductivity (ECe) 0.52 dsm$^{-1}$, total nitrogen 0.14%, available phosphorus 10.1 mgkg$^{-1}$, available potassium 389 mgkg$^{-1}$, zinc 0.83, iron 3.6 and manganese 4.0 mg per kg soil for year of 2011. Fertilizers were used as follows: 200 kg P2O5/ha and 50 kg N/ha and mixed with soil and land was ploughed once and harrowed twice. Seeds were soaked in 10% sugar solution; then each kg of seeds inoculated with 2 grams of BradyRhizobium japonicum. This experiment included 27 treatments that were placed in 81 plots. The plots consisted of six rows, 5 m in length spacing 60 cm apart. The distance between plants within a row was 5 cm and plant density was 333000 plants/ha. The plant density was achieved by over planting and thinning at V3 stage. Usage amounts of fertilizers zinc (0, 20 and 40 kg/ha from ZnSO4 source), iron (0, 25 and 50 kg/ha from FeSO4 source) and manganese (0, 20 and 40 kg/ha from MnSO4 source) were calculated based on plots area surface; next, fertilizers were mixed with soft soil at the ratio of 1:5 and placed on furrows made manually next to the stacks. At the different reproductive growth stages of soybean (flowering stage, pod set stage, seed filling period stage, and maturity stage) based on Fehr and Caviness, (1977), five plants were selected from each plot randomly. To measure concentration of micronutrients in leaves, leaves on the most top trifoliate of the plants were used, and leaves were separated from stem. At the end of growing season, five plants were selected from each plot and seeds were separated from pods. Samples (leaves, stems, pods and seeds, separately) washed with distilled water and were dried in the oven at 70°C for 48 hours, weighed, and incinerated at 550°C. Dry ash samples were soluble in concentrated HNO3 andHCLO4. Micronutrients were determined by Atomic Absorption Spectrometry (AAS) according to Kacar, (1984), and then ratios of micronutrients in soybean organs were calculated. Excel software was used to draw figures.

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## RESULTS AND DISCUSSION

The results of Zn concentrations in stem and leaf at different growth stages of soybean affected by zinc fertilization were shown in Figure (1). Based on results obtained, with increases soybean old from onset flowering to final maturity, Zn concentration declined in stem and leaves. These results were observed at all levels of zinc fertilizer (Zn0 to Zn40). Hence, the zinc concentrations in stem and leaves at R1stage were higher than the other stages. However, this decline was more in the stem compared the leaves. Zinc is transferred from the stem to leaves and then to pods and seeds coincidence to increase soybean old. In soybean stem and in Zn0, Zn20 and Zn40 treatments, Zn concentration at onset flowering compared final maturity was decreased and from 11.26, 12.97 and 14.10 mg.kg$^{-1}$ reached to 2.51, 3.34 and 3.67 mg.kg$^{-1}$ (-77.71%, -74.25% and -73.97%, respectively), while, in soybean leaves these reductions were recorded -29.11%, -29.65% and -16.55% (in Zn0, Zn20 and Zn40 treatments, 22.27, 29.68 and 31.30 mg.kg$^{-1}$in onset flowering reached to 15.79, 20.88 and 26.12 mg.kg$^{-1}$in final maturity, respectively). The Zn content in leaves was more than the stem in all the growth stages. These results agreed with the findings of Phiv and Hongprayoon, 2003). The effects of zinc, iron and manganese fertilizations on [Zn]leaf/[Zn]stem, [Zn]pod/[Zn]stem, [Zn]pod/[Zn]leaf ratios at reproductive growth stages of soybean were shown in Figure (2 a to i). [Zn]leaf/[Zn]stem ratio was increased with zinc, iron and manganese applications, So that with application of the elements, the ratio of [Zn]leaf to [Zn]stem was more than 6.5 times (Fig 2 a, b and c). Indeed, applications of these micronutrients causes the more zinc transferred through the stem to the leaves. Minimum and maximum impact on this ratio was observed at stages of R1 to R3 and R3 to R6, respectively. R3 stage onward, transfer rate of zinc through the stem to the leave was enhanced and this caused that [Zn]leaf/[Zn]stem ratio increased rapidly. The upward trend of [Zn]leaf/[Zn]stem up to R8 stage was maintained with zinc and manganese application, whereas, iron application had no effect on this ratio at R6 to R8 stage. Based on results, the range of pod set and seed filling period are critical stages for transfer of iron from stem to leave of soybean. The highest value of [Zn]leaf/[Zn]stem was recorded when that Zn40, Fe50 and Mn40 were used. This ratio was varied from about 2 to 7.5 times in R1 to R8 stages. It seems that, the leaves are the plant organs for Temporary storage of zinc. These results showed that in soybean, leaves role at the end of growing season (R8) as a reservoir for the accumulation of zinc is more important. Zhang et al., (2007) reported that Leaves are temporary sink for the accumulation of zinc in plants. Therefore, soybean genotypes that hold more leave at the end of growing season are effective in transferring of zinc to the grain growing. The similar results were reported by Grusak et al., (1999) and Waters and Sankaran, (2011). Zinc, iron and manganese fertilizations coinciding with increases soybean old (during R6 to R8 stage) the ratio of [Zn[pod/[Zn]stem was reduced (Fig 2 d, e and f). With application of 20 kg zinc, [Zn]pod/[Zn]stem was more than eight times at R6 stage (Fig 2 d), while, at this stage, the maximum values of [Zn]pod/[Zn]stem ratio were recorded in Fe50 and Mn40 treatments (Fig 2 e and f). At the end of the growing season of soybean, this ratio was dropped to seven times. Similar trends were observed in the ratio of [Zn]pod/[Zn]leaf. This result indicated that, zinc concentration in soybean pods was higher than the leaves. Finally destination of zinc are seeds (Marschner, 1995) and at R6 and R8 growth stages, zinc transfer to the seeds, therefore, this is normally that [Zn]pod and seed more than the [Zn]stem and leaves. The ratio of Zn]pod/[Zn]leaf was equal to 1.5 times when that 20 kg zinc per hectare was applied (Fig 2 g), while, this ratio was less than 1.4 times when iron and manganese fertilizers were used (Fig 2 h and i). It seems that, zinc transfer from pods to grains at the R6 stage is a reason to reduction of [Zn]pod/[Zn]stem and [Zn]pod/[Zn]leaf ratios. The effects of zinc, iron and manganese fertilizations on soybean [Zn]seed/[Zn]stem, [Zn]seed/[Zn]leaf and [Zn]seed/[Zn]pod ratios were shown in Figure (3). In our experiment, [Zn]seed/[Zn]stem, [Zn]seed/[Zn]leaf and [Zn]seed/[Zn]pod ratios were recorded more than 9, 1.4 and 1.2 times, respectively. The highest [Zn]seed/[Zn]stem, [Zn]seed/[Zn]leaf and [Zn]seed/[Zn]pod ratios were obtained in Zn40 treatment (11.38, 1.60 and 1.72, respectively). Lack of zinc (Zn0 treatment) were reduced these ratios. This is consistent with previous reports on rice (Jiang et al., 2008). Meng et al. (2005) stated that micronutrients fertilization was one of the most important ways for the enhancement of absorption, transport and accumulation of micronutrients in plants. The effects of zinc, iron and manganese on soybean Seed [Zn]/[Fe] and Seed [Zn]/[Mn] were shown in Figure (4). According to these results, iron application reduced [Zn]seed/[Fe]seed ratio, while, the highest ratio of [Zn]seed/[Fe]seed was recorded in Zn40 and Fe0 treatments. Manganese fertilization had no significantly
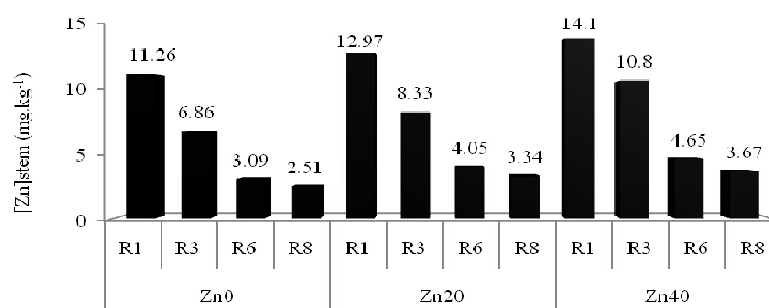
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effect on [Zn]seed/[Fe]seed ratio. Concerning [Zn]seed/[Mn]seed ratio, the lack of manganese had greater effect compared zinc application, therefore, the highest value of this ratio was obtained in Mn0 treatment (1.38).

## ACKNOWLEDGMENTS

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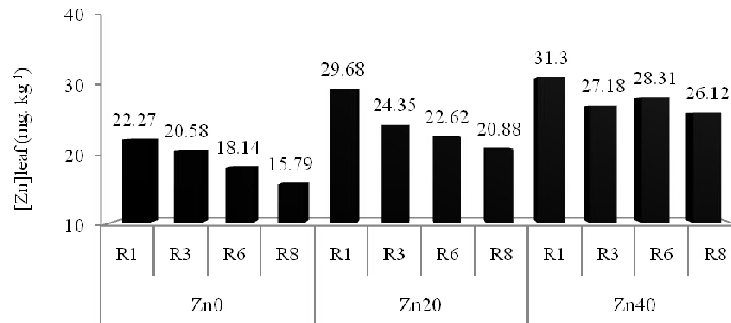
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**Figure 1- The effects of zinc fertilization on Zn concentrations in stem and leaf of soybean (mg.kg$^{-1}$) at R1 (early of flowering), R3 (early of pod set), R6 (seed filling period) and R8 (full maturity)**
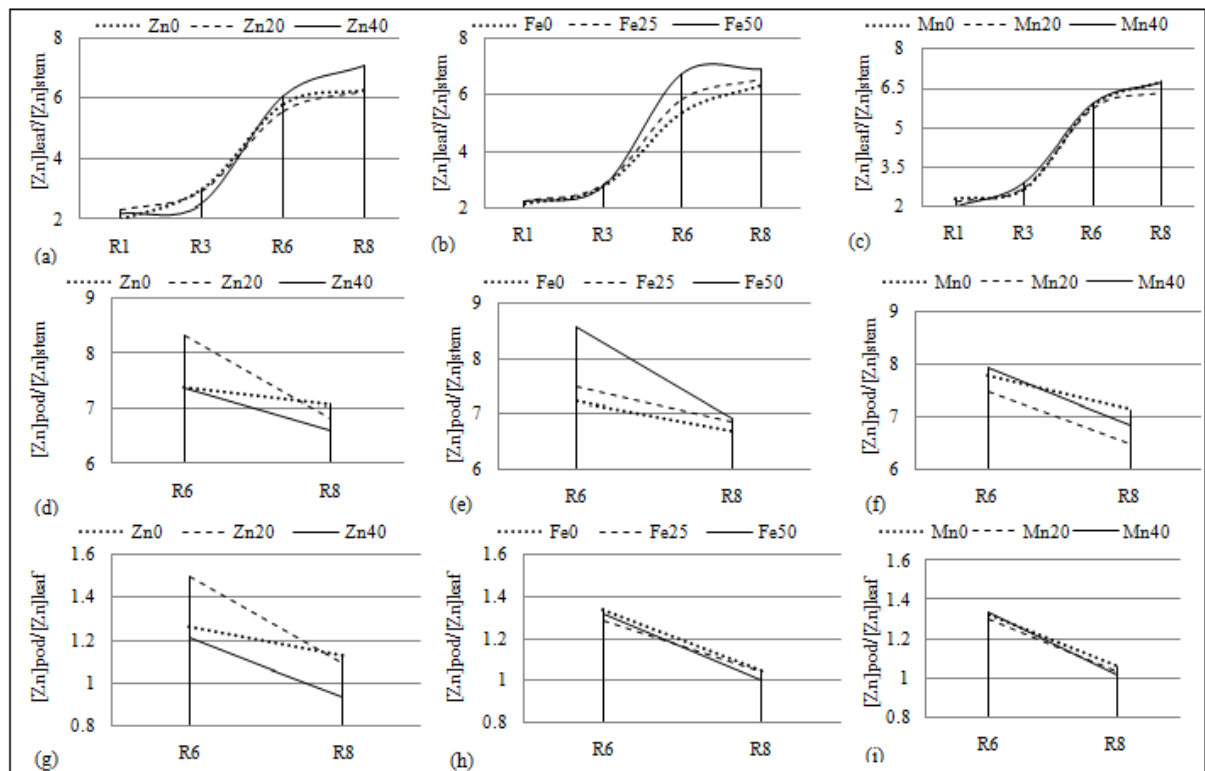


Figure 2- The effects of zinc, iron and manganese fertilizations on soybean [Zn]leaf/[Zn]stem, [Zn]pod/[Zn]stem, [Zn]pod/[Zn]leaf ratios (a to i)
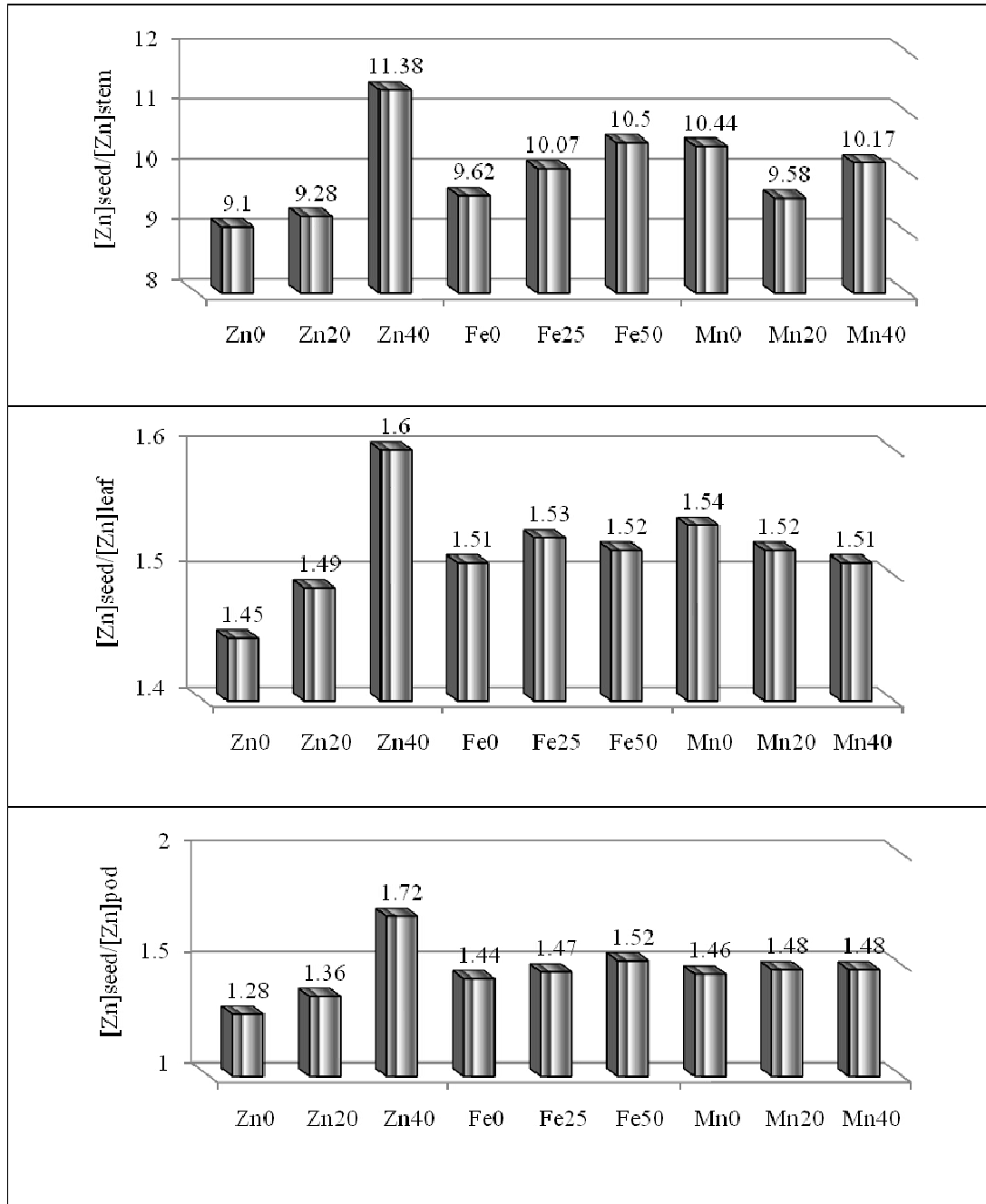
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**Figure 3- The effects of zinc, iron and manganese fertilizations on soybean
[Zn]seed/[Zn]stem, [Zn]seed/[Zn]leaf and [Zn]seed/[Zn]pod ratios**
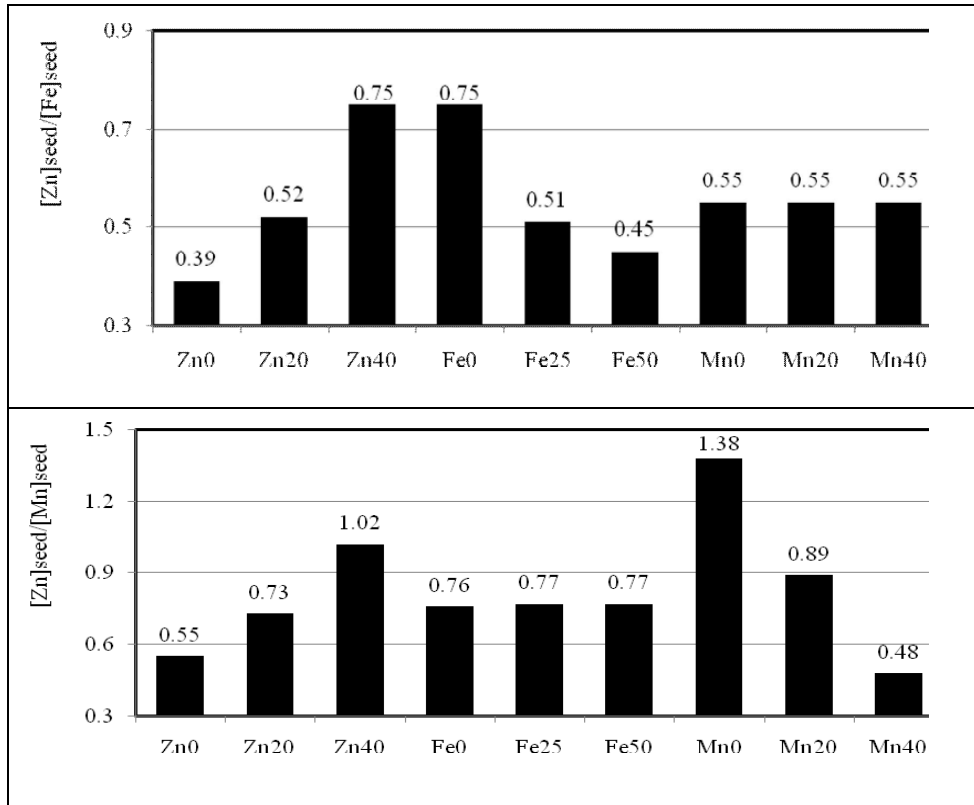
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**Figure 4- The effects of zinc, iron and manganese on soybean Seed [Zn]/[Fe] and Seed [Zn]/[Mn]**

**RESEARCH ARTICLE**

# The Effects of Foliar Spraying of Manganese and Drought Stress on Soybean Production

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**ABSTRACT**

In order to investigation responses of soybean to manganese foliar application and drought stress, a field experiment was conducted as  split split plot based on Randomized Complete Block design with three replicates at research station of Islamic Azad University, Kermanshah province, Iran during the 2012 growing season. At the end of growing season, economic and biological yield were determined. Also, oil and protein contents in soybean grain were measured. Statistical analysis showed that irrigation and manganese interaction had significant effects on economic and biological yield, while, this treatment had no significant effects on oil and protein in soybean grain. In addition, there are significant differences among cultivars in economic and biological yield. Based on results obtained, withholding irrigation at flowering stage reduced oil, protein, economic and biological yield, but this reduction was not statistically significant for the oil. The lowest oil, protein, economic and biological yield were recorded in $I_2Mn_0C_2$, $I_1Mn_0C_4$, $I_2Mn_0C_5$, and $I_2Mn_0C_4$ treatments.

**Key words**: micronutrient, oil, protein, soybean, yield

## INTRODUCTION

In calcareous soils, wet and dry periods can influence manganese availability by root plants. Under drought stress, plant roots cannot absorb micronutrients (Heidarian et al., 2011), such as manganese, and foliar spraying of

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manganese is useful and more influential as compared to soil application (Narimani et al., 2010). In the other side, Soybean is considered a sensitive crop to drought stress (Lobato et al., 2008) and manganese deficiency (Barker and Pilbeam, 2007). Manganese fertilization could be very important in the case of soybean grown in soil with low manganese availability (Hellal and Abdelhamid, 2013) especially at water deficit conditions (Vadez et al., 2000). Recent evidence in the literature indicates that deficiencies in minerals due to drought stress at any plant growth stage result in poor seed quality and low yield (Bellaloui et al., 2013). In addition, drought stress is recognized as a affecting factor in soybean oil and protein contents (Kumuwat et al., 2000; Rotundo et al., 2009; Kirnak et al., 2010). Based on (Wilson, 1995; Liu et al., 1995; Maestri et al., 1998) studies Protein and oil content, chemical composition of oil and protein, and grain appearance are three important factors determining the quality of soybean. Previous studies indicated that there exists an inverse relationship between seed protein and oil concentration (Panthee et al., 2006; Okporie and Oselebe, 2007), and there is positively correlation between quality traits with seed yield as a quantity trait (Rajni et al., 1983). Therefore, the main objective of this study was to evaluate the effects of withholding irrigation and manganese foliar treatments on some quantitative and qualitative traits in eight cultivars of soybean.

## MATERIALS AND METHODS

This experiment was conducted as split split plot in randomized complete block design with three replications in 96 plots at Agricultural Research field of Islamic Azad University of Kermanshah, Iran (34°23' N, 47°8' E; 1351 m elevation) during the 2012 growing season. Eight commercial soybean cultivars, Clark ($V_1$), Williams ($V_2$), Sahar or Pershing ($V_3$), Hobbit ($V_4$), Gorgan 3 ($V_5$), M7 ($V_6$), M9 ($V_7$), and DPX ($V_8$), were grown under field conditions. Main plot treatments consisted two irrigation regimes: ($I_1$) Irrigation at all of growth stages, ($I_2$) Irrigation Withholding at flowering stage, Subplot included ($Mn_0$) spray with distilled water, ($Mn_1$) manganese spray, and eight soybean cultivars arraigned in sub subplot. Soil samples were collected from experimental area at 0-30 cm depth. The texture of the soil based on silty clay with (silt 49.1%, clay 42.4%, and sand 8.5%), pH 7.3, organic matter 2.6, total nitrogen 0.11%, available phosphorus, potassium, zinc, iron and manganese 8.2, 531, 0.81, 2.76, and 4.49, respectively. All seeds were inoculation with Bradyrhizobium japonicum immediately before sowing. Each plot was 6 m in length, 2.4 m in width, 0.6 m in row spacing, and with density of 33 plants per meter square. The quantity of irrigation water in each plot was calculated according to (Karam et al., 2005), controlled by counter and exercise irrigation treatment at flowering stage. At the $V_4$ growth stage based on (Fehr and Caviness, 1977), the plants were sprayed twice (with one week interval) with 0.5% manganese liquid or distilled water until the leaves were wet. At the end of growing season and harvest time, two middle rows of each plot were completely harvested considering the sides. Weight 13% deduction of moisture, grain dry weight was calculated and considered as economic yield. To determine biological yield, total plant dry weight was employed as biological yield. Also, oil and protein contents in soybean grain were measured according to (Emami, 1996; Jung et al., 2003). Data for evaluated traits were statistically analyzed using a standard analysis of Variance technique using the MSTATC software. Means were separated by the Least Significance Difference Test (LSD) at 5 percent probability level.

## RESULTS AND DISCUSSION

The results of analysis of variance were shown in Table (1). Irrigation treatments made significant effects on oil at 5% level, and economic and biological yield at 1% level. The similar results were reported by (Aderolu, 2000). Also, manganese foliar application had significant effects on protein (P<0.05), and economic and biological yield (P<0.01). While, Protein and oil unaffected by irrigation and manganese treatments, respectively (Table 1). The positive effect of manganese foliar application on seed protein of safflower was emphasized by (Movahhedy-Dehnavy et al., 2009). Statistical analysis showed that irrigation and manganese interaction had significant effects on economic and biological yield, while, (I) × (Mn) treatment had no significant effects on oil and protein in soybean grain. The similar results were obtained by (Babaeian et al., 2011). The results of this experiment show that there are significant differences among cultivars in economic and biological yield (P<0.01). Among soybean cultivars there was no

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significant difference in terms of oil and protein. Effect of (I) × (C) and (Mn) × (C) interactions on biological yield were significant probability levels at 1% and 5%, respectively. Whereas, other evaluated traits unaffected by these interaction effects. Oil and protein contents were not affected by the interaction of (I) × (Mn) ×(C). In contrast, interaction effect of (I) × (Mn) ×(C) treatment had significant effects on economic yield (P<0.05) and biological yield (P<0.01). The results of means comparison (Table 2) were shown that withholding irrigation at flowering stage in $I_2$ treatment reduced oil, protein, economic and biological yield compared regular irrigation ($I_1$ treatment), However, this reduction was not statistically significant for the oil. These results are somewhat different from the results obtained by (Zaman and Das, 1991). With manganese foliar application, protein content, economic and biological yield increased by 5.47%, 12.95%, and 13.96%, respectively. Hellal and Abdelhamid, (2013) reported that total manganese uptake by the soybean plants per metric ton of grain production is 123 grams. Manganese fertilization increased oil content in soybean grain, but this increased was not statistically significant. These results are in contrast with the results obtained by Yasari, (2012) that showed the highest seed oil yield in soybean was obtained by applying manganese. Economic yield ranged between 2305.83 to 1627.50 kg/ha$^{-1}$ in cultivars. The highest and lowest economic yield was observed in $C_2$ and $C_4$ cultivars, respectively. The similar results for biological yield was observed and among cultivars $C_2$ and $C_4$ had the highest and lowest biological yield with 6159.25 and 4679.17 kg/ha$^{-1}$ (Table 2). Based on results obtained, the highest oil, economic and biological yield were achieved with manganese spray at regular irrigation (I1Mn1 treatment) by 19.92%, 2605.12 and 6949.72 kg/ha, respectively. So that, there are significantly differences between cultivars concerning oil and protein contents in soybean grain at different irrigation regimes (Table 3). Furthermore, at all of cultivars evaluated the highest economic and biological yield belonged to I1 (regular irrigation). Among cultivars $C_2$ had the highest economic yield (2828.41kg/ha) and biological yield (7608.43 kg/ha). Manganese application compared distilled water spray at water deficit condition led to increase in oil, protein, economic and biological yield by 4.81%, 6.19%, 22.23%, and 23.19%, respectively (Table 3). These results are agreement with Movahhedy-Dehnavy et al., (2009) and Ghofran Maghsud et al., (2014) finding. Fageria, (2007) and Hellal and Abdelhamid, (2013) emphasized that micronutrients such as manganese have important role in growth and yield of crops. In addition, Mn plays an important role in stabilization of structural protein (Popelkova et al., 2003). Concerning oil content in grain, response of Clark and Pershing cultivars to manganese application was better than the other cultivars tested. While, at manganese spray condition Hobbit, M9, and DPX cultivars had more protein in grains. In $M_1$ treatment, the highest economic and biological yield was recorded in Williams cultivar (Table 3). Means comparison of quantity and quality traits in soybean grain under (I) × (Mn) ×(C) interaction effects was shown in table (4). Generally, the highest oil, economic and biological yield were observed when that manganese was applied in irrigation regular treatment. Bellaloui et al., (2013) reported that nutrients deficiencies due to drought stress at any plant growth stage result in low quality and yield of crops. While, withholding irrigation and manganese application increased protein content in soybean grain. The role of micronutrients application in protein synthesis in crops grain was emphasized by Ziaeian and Malakoti, (2002) study. Clark cultivar had the highest oil content in the grains. Among cultivars, DPX had more protein in the grain and the highest economic and biological yield belonged to Williams cultivar. The lowest oil, protein, economic and biological yield were recorded in $I_2Mn_0C_2$, $I_1Mn_0C_4$, $I_2Mn_0C_5$, and $I_2Mn_0C_4$ treatments. There was a significant and positive correlation between economic yield with oil percentage (r=0.692$^*$), and biological yield (r=0.965$^{**}$) (Table 5).Also, biological yield had a significant and positive correlation with oil content in soybean grain (r=0.680$^*$). In our experimental conditions, a significant correlation between oil and protein content in soybean grain was not recorded.

## ACKNOWLEDGMENTS

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**Table1. The results of analysis variance of oil, protein, economic and biological yield in eight soybean cultivars under short-term drought stress and manganese foliar application**

| | MS | | | | | | |
|---|---|---|---|---|---|---|---|
| **Source of variation** | | **df** | | **Oil** | **Protein** | **Economic yield** | **Biological yield** |
| Replication | | 2 | | 8.46 | 2.21 | 8298.76 | 8192.01 |
| Irrigation(I) | | 1 | | 57.35$^*$ | 2.34$^{ns}$ | 22512782.51$^{**}$ | 150695805.04$^{**}$ |
| Error(a) | | 2 | | 1.97 | 6.49 | 26159.19 | 1860.51 |
| Manganese (Mn) | | 1 | | 12.04$^{ns}$ | 102.09$^*$ | 1460513.34$^{**}$ | 12009105.37$^{**}$ |
| (I)×(Mn) | | 1 | | 0.51$^{ns}$ | 1.65$^{ns}$ | 95319.01$^{**}$ | 611523.37$^{**}$ |
| Error(b) | | 4 | | 1.60 | 10.59 | 10297.89 | 23523.53 |
| Cultivar(C) | | 7 | | 0.27$^{ns}$ | 1.18$^{ns}$ | 518187.20$^{**}$ | 2868205.45$^{**}$ |
| (I) ×(C) | | 7 | | 0.14$^{ns}$ | 0.91$^{ns}$ | 32207.27$^{ns}$ | 422829.59$^{**}$ |
| (Mn) ×(C) | | 7 | | 0.10$^{ns}$ | 1.11$^{ns}$ | 30757.72$^{ns}$ | 116439.54$^*$ |
| (I) ×(Mn) ×(C) | | 7 | | 0.37$^{ns}$ | 0.74$^{ns}$ | 41634.06$^*$ | 428722.11$^{**}$ |
| Error(c) | | 56 | | 0.43 | 2.14 | 17476.46 | 45990.79 |
| Coefficient of variation (%) | | - | | 6.47 | 8.79 | 9.52 | 10.69 |

-ns, * and **: Non significant, significant at 5 and 1% levels of probability, respectively.

**Table2-Means comparison of qualitative and quantitative traits in eight soybean cultivars under short-term drought stress and manganese foliar application**

| Treatment | Means | | | |
|---|---|---|---|---|
| | Oil (%) | Protein (%) | Economic yield (kg/ha) | Biological yield (kg/ha) |
| Irrigation | | | | |
| $I_1$ | 19.64a | 38.51a | 2512.75a | 6674.75a |
| $I_2$ | 18.09b | 38.82a | 1544.23b | 4168.96b |
| Manganese | | | | |
| $Mn_0$ | 18.52ab | 37.64b | 1905.15b | 5068.17b |
| $Mn_1$ | 19.23a | 39.70a | 2151.83a | 5775.54a |
| Cultivar | | | | |
| $C_1$ | 18.95a | 38.50a | 2034.08cd | 5457.50c |
| $C_2$ | 18.65a | 38.65a | 2305.83a | 6159.25a |
| $C_3$ | 19.07a | 39.00a | 2186.08b | 5727.50b |
| $C_4$ | 18.75a | 38.60a | 1931.50de | 5083.92d |
| $C_5$ | 18.73a | 38.18a | 1627.50f | 4679.17e |
| $C_6$ | 18.90a | 38.43a | 1826.08e | 4927.50d |
| $C_7$ | 18.89a | 39.10a | 2148.25b | 5696.00b |
| $C_8$ | 19.03a | 38.90a | 2123.58bc | 5644.00b |
| LSD value | 0.53 | 1.19 | 108.10 | 175.41 |

* Similar letters in each column shows non-significant difference according to LSD test in %5 level.
** $I_1$: irrigation at all of growth stages, and $I_2$: withholding irrigation at flowering growth stage;
$Mn_0$: spray with distilled water, and $Mn_1$: manganese spray; $C_1$: Clark, $C_2$: Williams, $C_3$: Pershing, $C_4$: Hobbit, $C_5$: Gorgan3, $C_6$: M7, $C_7$: M9, $C_8$: DPX.

**Table3-The effect of (I) × (Mn) and (I) × (C) interactions on soybean qualitative and quantitative traits**

| Treatment | Means | | | |
|---|---|---|---|---|
| | Oil (%) | Protein (%) | Economic yield (kg/ha) | Biological yield (kg/ha) |
| (I) × (Mn) | | | | |
| $I_1 Mn_0$ | 19.36ab | 37.61a | 2421.26b | 6401.28b |
| $I_1 Mn_1$ | 19.92a | 39.41a | 2605.12a | 6949.72a |
| $I_2 Mn_0$ | 17.67c | 37.66a | 1389.51d | 3735.69d |
| $I_2 Mn_1$ | 18.52bc | 39.99a | 1699.36c | 4602.01c |
| LSD value | 1.013 | 2.609 | 81.331 | 122.910 |
| (I) × (C) | | | | |
| $I_1 C_1$ | 19.70a | 35.25a | 2442.85c | 6484.55d |
| $I_1 C_2$ | 19.45a | 38.20a | 2828.41a | 7608.43a |
| $I_1 C_3$ | 19.80a | 38.95a | 2672.38b | 6938.06c |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $I_1C_4$ | | 19.60a | | 38.00a | | 2403.74cd | 6283.85de |
| $I_1C_5$ | | 19.55a | | 38.20a | | 2141.29e | 5750.64f |
| $I_1C_6$ | | 19.85a | | 38.70a | | 2270.23de | 6078.65e |
| $I_1C_7$ | | 19.51a | | 38.95a | | 2642.68b | 7048.22bc |
| $I_1C_8$ | | 19.70a | | 38.85a | | 2705.55ab | 7211.52b |
| $I_2C_1$ | | 18.20b | | 38.75a | | 1626.34gh | 4431.11h |
| $I_2C_2$ | | 17.85b | | 39.10a | | 1784.46f | 4711.26g |
| $I_2C_3$ | | 18.35b | | 39.05a | | 1700.26fg | 4518.92gh |
| $I_2C_4$ | | 17.90b | | 39.20a | | 1460.62ij | 3885.71ij |
| $I_2C_5$ | | 17.90b | | 38.15a | | 1204.23k | 3609.44k |
| $I_2C_6$ | | 17.95b | | 38.15a | | 1383.98j | 3778.31jk |
| $I_2C_7$ | | 18.25b | | 39.25a | | 1655.71fgh | 4345.77h |
| $I_2C_8$ | | 18.35b | | 38.95a | | 1543.06hi | 4077.43i |
| LSD value | | 0.75 | | 1.69 | | 152.95 | 248.01 |

 * Similar letters in each column shows non-significant difference according to LSD test in %5 level.

** $I_1$: irrigation at all of growth stages, and $I_2$: withholding irrigation at flowering growth stage;

$Mn_0$: spray with distilled water, and $Mn_1$: manganese spray; $C_1$: Clark, $C_2$: Williams, $C_3$: Pershing, $C_4$: Hobbit, $C_5$: Gorgan3, $C_6$: M7, $C_7$: M9, $C_8$: DPX.

**Continue of Table3**

| Treatment | | Means | | | | | |
|---|---|---|---|---|---|---|---|
| | | Oil (%) | | Protein (%) | | Economic yield (kg/ha) | Biological yield (kg/ha) |
| $(Mn) \times (C)$ | | | | | | | |
| $Mn_0C_1$ | | 18.45cd | | 37.30f | | 1963.51ef | 5238.50de |
| $Mn_0C_2$ | | 15.25d | | 37.95cdef | | 2136.40cd | 5668.36c |
| $Mn_0C_3$ | | 18.75abcd | | 38.20bcdef | | 1991.35def | 5322.97d |
| $Mn_0C_4$ | | 18.55bcd | | 37.05f | | 1890.42fg | 4853.71fg |
| $Mn_0C_5$ | | 18.40cd | | 37.35ef | | 1549.35i | 4302.19h |
| $Mn_0C_6$ | | 18.51cd | | 37.65def | | 1723.91h | 4641.60g |
| $Mn_0C_7$ | | 18.48cd | | 38.00cdef | | 2017.20def | 5256.43de |
| $Mn_0C_8$ | | 18.75abcd | | 37.60def | | 1974.68ef | 5267.66de |
| $Mn_1C_1$ | | 19.46a | | 39.70ab | | 2106.25de | 5677.82c |
| $Mn_1C_2$ | | 19.05abc | | 39.35abc | | 2476.09a | 6651.85a |
| $Mn_1C_3$ | | 19.42a | | 39.80ab | | 2382.13ab | 6134.48b |
| $Mn_1C_4$ | | 18.95abcd | | 40.15a | | 1973.62ef | 5315.76d |
| $Mn_1C_5$ | | 19.05abc | | 39.00abcde | | 1797.53gh | 5057.94ef |
| $Mn_1C_6$ | | 19.30ab | | 39.20abcd | | 1929.40fg | 5215.18de |
| $Mn_1C_7$ | | 19.30ab | | 40.20a | | 2280.08bc | 6137.25b |
| $Mn_1C_8$ | | 19.30ab | | 40.20a | | 2273.22bc | 6021.74b |
| LSD value | | 0.75 | | 1.69 | | 152.93 | 248.06 |

* Similar letters in each column shows non-significant difference according to LSD test in %5 level.

**Mn_0: spray with distilled water, and Mn_1: manganese spray; C_1: Clark, C_2: Williams, C_3: Pershing, C_4: Hobbit, C_5: Gorgan3, C_6: M7, C_7: M9, C_8: DPX.

**Table4-Means comparison of soybean qualitative and quantitative traits under (I) × (Mn) ×(C) interaction effect**

| Treatment | | Oil (%) | | Protein (%) | | Economic yield (kg/ha) | | Biological yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| (I) ×(Mn) ×(C) | | | | | | | | |
| $I_1Mn_0C_1$ | | 19.32abcdefg | | 37.12hi | | 2353.86fgh | | 6185.68f |
| $I_1 Mn_0C_2$ | | 19.11bcdefgh | | 37.58efghi | | 2679.44bcd | | 7091.84bcd |
| $I_1 Mn_0C_3$ | | 19.70abcde | | 38.42bcdefghi | | 2509.68defg | | 6766.22de |
| $I_1 Mn_0C_4$ | | 19.52abcdef | | 36.20i | | 2495.87defg | | 6389.76f |
| $I_1 Mn_0C_5$ | | 18.93cdefghi | | 37.56efghi | | 1976.35ij | | 5264.00h |
| $I_1 Mn_0C_6$ | | 19.76abcde | | 37.95defghi | | 2157.71hi | | 5651.51g |
| $I_1 Mn_0C_7$ | | 19.20abcdefgh | | 38.24cdefghi | | 2609.68cd | | 6874.21cd |
| $I_1 Mn_0C_8$ | | 19.51abcdef | | 38.18defghi | | 2589.08de | | 6987.29cd |
| $I_1Mn_1C_1$ | | 20.13ab | | 39.41abcdefgh | | 2531.66def | | 6783.44de |
| $I_1 Mn_1C_2$ | | 19.80abcd | | 38.90abcdefgh | | 2976.97a | | 8125.07a |
| $I_1 Mn_1C_3$ | | 19.94abc | | 39.51abcdefg | | 2835.14ab | | 7109.73bcd |
| $I_1 Mn_1C_4$ | | 19.78abcde | | 39.82abcde | | 2311.75gh | | 6177.70f |
| $I_1 Mn_1C_5$ | | 20.21a | | 38.90abcdefgh | | 2306.68gh | | 6235.41f |
| $I_1 Mn_1C_6$ | | 20.00ab | | 39.55abcdefg | | 2382.47efg | | 6504.08ef |
| $I_1 Mn_1C_7$ | | 19.83abcd | | 39.76abcdef | | 2675.55bcd | | 7221.39bc |
| $I_1 Mn_1C_8$ | | 19.92abc | | 39.62abcdef | | 2820.76abc | | 7435.79b |
| $I_2Mn_0C_1$ | | 17.65kl | | 37.53efghi | | 1572.45mnop | | 4291.55ij |
| $I_2Mn_0C_2$ | | 17.44l | | 38.40bcdefghi | | 1592.54mno | | 4245.76jk |
| $I_2Mn_0C_3$ | | 17.80jkl | | 38.00defghi | | 1472.08nopq | | 3877.12lm |
| $I_2Mn_0C_4$ | | 17.68kl | | 37.96defghi | | 1285.00qr | | 3318.40n |
| $I_2Mn_0C_5$ | | 17.93ijkl | | 37.21ghi | | 1121.47r | | 3339.31n |
| $I_2Mn_0C_6$ | | 17.34l | | 37.45fghi | | 1289.77qr | | 3630.71lmn |
| $I_2Mn_0C_7$ | | 17.77jkl | | 37.83defghi | | 1425.78opq | | 3637.90lmn |
| $I_2Mn_0C_8$ | | 18.04ijkl | | 37.09hi | | 1359.06pq | | 3547.64mn |
| $I_2Mn_1C_1$ | | 18.81defghij | | 40.08abcd | | 1680.91lmn | | 4571.27ij |
| $I_2Mn_1C_2$ | | 18.33ghijkl | | 39.81abcde | | 1976.05ij | | 5176.06h |
| $I_2Mn_1C_3$ | | 18.90cdefghi | | 40.11abcd | | 1928.28jk | | 5158.98h |
| $I_2Mn_1C_4$ | | 18.22hijkl | | 40.50abc | | 1635.62mno | | 4452.01ij |
| $I_2Mn_1C_5$ | | 17.90ijkl | | 39.10abcdefgh | | 1287.12qr | | 3879.80lm |
| $I_2Mn_1C_6$ | | 18.63fghijk | | 38.94abcdefgh | | 1476.33nopq | | 3925.27kl |
| $I_2Mn_1C_7$ | | 18.85defghij | | 40.70ab | | 1884.43jkl | | 5052.54h |
| $I_2Mn_1C_8$ | | 18.72efghij | | 40.89a | | 1726.51klm | | 4607.25i |
| LSD value | | 1.07 | | 2.39 | | 216.21 | | 350.80 |

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* Similar letters in each column shows non-significant difference according to LSD test in %5 level.

**$I_1$: irrigation at all of growth stages, and $I_2$: withholding irrigation at flowering growth stage; $Mn_0$: spray with distilled water, and $Mn_1$: manganese spray; $C_1$: Clark, $C_2$: Williams, $C_3$: Pershing, $C_4$: Hobbit, $C_5$: Gorgan3, $C_6$: M7, $C_7$: M9, $C_8$: DPX.

**Table5- Pearson correlation coefficients among evaluated traits in eight soybean cultivar under short-term drought stress and manganese application**

|  | O% | P% | Economic yield | Biological yield |
|---|---|---|---|---|
| O% | 1.00 | $0.077^{ns}$ | $0.692^{*}$ | $0.680^{*}$ |
| P% |  | 1.00 | $0.090^{ns}$ | $0.099^{ns}$ |
| Economic yield |  |  | 1.00 | $0.965^{**}$ |
| Biological yield |  |  |  | 1.00 |

-ns, * and **: Non significant, significant at 5 and 1% levels of probability, respectively.

**RESEARCH ARTICLE**

# Study of Waste Management Process in Iran and the World

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**ABSTRACT**

Given the importance of waste generation, in this paper, we investigate the process of waste management in Iran and the world so that, by comparing the process of waste management in the industrial countries and Iran, we can find out our strengths and weaknesses, and improve them. We discussed waste generation quantity and management in three cities of Istanbul, San Francisco, and Adelaide, and compared their municipal solid waste management situation with Tehran city in Iran. This is a descriptive survey. Our findings showed that solid waste management methods in Iran are not in harmony with waste management criteria in advanced industrialized countries, and they depend on climate, culture, and geographical conditions.

**Key words:** waste management, solid waste management, municipal solid waste, MSW, MSWM

## INTRODUCTION

Waste is unusable materials that can cause adverse effects on human health and nature due to combustion, reactivity, corrosivity and toxicity properties. Hence proper management and disposal of the materials, diversity of waste product, essential and disposal management requires essential and scientific disposal management, especially hazard management, which takes on great importance. Aiming at securing the environment and human being as well as all beings now and in the future, we need to avoid detrimental effects that have been released back into the cycle and threatening us (such as Newton's action-reaction law). Accordingly, with respect to water, soil, and air sustainability, acute crises of the environment caused by lack of regulations, appropriate regional, national, and international

financial and legal limitations on disposal, separation of a variety of waste, or nonconformity to the nature, as well as traditional disposal (including releasing all pollutants, and various household, industrial, hospital, etc., cleaning materials back into the environment, it is necessary to take necessary and extraordinary measures (Shaghaghi et al, 2013).

Due to the growing trend of waste generation from one hand, and lack of a strategy and necessary regulation to manage these materials from other hand; many parts of Iran have been faced with serious problems, and caused plenty of environmental losses and risks. Regardless of waste collection inside cities, which is undertaken rather optimally, in most cases, the disposal causes troubles, as waste landfill is invariably taken place in an unsanitary fashion.  Hospital waste together with other type of waste are buried, or they are piled up or scattered in different areas, rendering great deal of surface and underground water resources contaminated as well as damaging natural ecosystem and people health. One of the main shortcomings in organizing the status of waste is lack of a comprehensive regulation, in which the responsibility of different governmental and non-governmental sectors as well as people clearly defined (Ghasempour et al, 2008).

Population growth, industrialization, and urbanization are three major reasons for unprecedented increase in the production of solid waste in the past two decades, and its social, financial, and environmental effects can be observed all over the world. In the meantime, Iran requires an investigation into the problem and strategies for proper waste management. Among various countries, no country has ever experienced such rapid rise in the amount of waste generation except china, in that management of municipal solid waste has become a crucial issue in this country. England has also a long history in the field of waste management (Sattar et al., 2008).  The key to success in waste management systems, public awareness and contribution to the programs associated with it. Solid waste is a result of human activity, which is why it is necessary for everybody to have a good understanding of waste management issues. The presence of aware service recipients is not only instrumental in achieving goals, but it also reduces costs in cooperation with them and their loyal support. To make people aware of their rights and duties toward waste management systems, there is a need to build a culture and deliver an ongoing education so that people are able to realize their role and significance and make an attempt to solve problems in cooperation with one another (Minoo Sepehr et al, 2013).

Waste management in big cities as it is reasonable and in compliance with environmental issues is considered one of the most important concerns discussed in the field of urban management. Raising public awareness of sanitary and environmental issues, on the one hand, and limited resources (energy and material) worldwide and increased demand particularly in developing countries have led urban plan makers to take action to develop and implement optimal methods for waste management, which is based on sustainable development viewpoint and takes account of economic, environmental, and social issues at the same time and in association with one another. The main components of a modern waste management system generally include generation, collection, separation, recycling, processing, and disposal. Separation, processing, and recycling are likely to be carried out at every stage of waste management. Design and implementation of a comprehensive and sustainable waste management require an investigation of various waste characteristics in a region (rate of generation, quality, quantity, source, etc.) and the qualities of city itself (existing infrastructure, economic potential, topography, climate, status of city streets, and public lifestyle, etc.) in detail. (Noorpour et al, 2013)

The aim of the study is to investigate how waste generation in Iran and the world is managed to see how close Iran is to the international standards in waste management, and to promote the principles of waste management in Iran, Iranians learn from industrialized and modern countries so that the greatest benefit can be achieved from waste material recycling and reuse of materials and utilization for other purposes, which in turn can bring Iranians economic efficiency as well as conservation of natural resources.

# MATERIALS AND METHODS

**Definition of waste**

According to the Organization for Economic Co-operation and Development (OECD), "Waste refers to materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose". According to United Nations Environment Program (UNEP), "waste is an object the holder discards, intends to discard or is required to discard."

Waste is by-product of human activities. Physically speaking, it contains the same materials as useful products, as the only difference lies in the state of waste no longer being of value. In most cases, such worthlessness comes from the mixed or unknown state of the materials consisting waste. Separation of waste materials can be one way to increase the value of materials and find the applicable instances associated with them. On the whole, there is an inverse relationship between the degree of mixed waste and its value. Waste can be classified from different point of views; physical state (solid, liquid, gas), main application (packaging, food materials, etc.), materials (glass, paper, etc.), physical characteristics (flammable, compost doable, recyclable), source (domestic, commercial, agricultural, industrial), level of safety (hazardous, safe). Domestic and commercial wastes are generally referred to as municipal solid waste (MSW), which normally contain less than 10 percent of total waste stream (as remaining ninety percent consists of agricultural waste, mining waste, industrial and manufacturing waste, energy production waste, water treatment waste, construction and demolition waste). Household (residual) waste has been usually seen as complex issue of urban management. Because of a wide range of materials contained in waste (glass, metal, paper, plastic, organic materials, etc.), and complete mixture of the materials, a variety of problems arise in managing them. Moreover, the composition of waste varies in different seasons, geographical areas, from country to country, from town to town, which is the very reason why a single version cannot be developed for all cities. Commercial and industrial wastes are often generated more uniformly in higher quantities, so a management system that can handle household waste is definitely capable of managing waste from other sources. (Noorpour et al. 2013)

**Waste management**

Waste management includes a set of consistent and systematic regulations on generation control, storage, collection, transport and transfer, and disposal of solid waste based on the best principles of public health, economy, resource conservation, aesthetic, and other environmental requirements and what appeals to the public (Tchobanoglous et al., 1993). Hierarchy of waste material management provides us with a clear prospect for designing the management of the materials, which determines strategy management and different alternatives based on the order of importance. The purpose of proposing the issue is that the best possible scientific approach to solid waste management, as the quantity of waste is reduced to a minimum. Avoid, reduce, reuse, recycle, recovery are considered preventive strategies and good alternatives and take the highest priority, while treat and landfill dispose are considered controlling strategies and good alternatives, and takes the lowest priority. Figure 1 depicts the hierarchy schematically.

With respect to waste management, there are three fundamental and key points for which we need to make an effort to realize them in compliance with the priorities. These are:

- An effort to reduce waste generation
- An effort to maximize recycle and reuse waste
- Safe and environmentally homogenous disposal as the whole, we can explain different solid waste management systems as follows:

- Sustainable management of solid waste, for which consumption pattern changes, energy and materials consumption reduction, and rubbish generation reduction are considered the most essential elements and viewed as one of the guidelines for sustainable development in the 21st century.
- Integrated management that includes reduction plans at the source, recycle, material transformation, and disposal of solid waste, in which reduction in source is the most important part.
- Environmental management that adopt sustainable improvement model and involve priorities, selections, and recognition based on costs, profit, and eventually revision and evaluation that we can see it as part of ISO 14000.
- Regional management in which climate, seasonal variations, budget, and financial constraints, economy, customs, social, cultural, religious factors, urban fabric, and environmental standards are concerned
- Strategies that include source reduction strategies, integrated life cycle, integrated control of pollution, and public participation of society.

**Waste Management components**

About solid waste management, the basis is the essential coordination and task determination of every collection management component and disposal of the materials. It seems that coherence and coordination of national solid waste management is a program, the execution of which is feasible by Ministry of Health, Ministry of agriculture, Ministry of Industry as well as a couple of universities in the country. The main strategy of the management should be planned and executed in five specific sections as shown in Figure 2 with respect to current financial and technical facilities as well as environmental conditions in the region. Accordingly, the components of the management should receive special attentions according to the current needs of every region in compliance with priorities within the framework of recycling, composting, sanitary landfilling, and disposal of hazardous and toxic waste (Tchobanoglous et al, 1993).

In addition to the previous model offered for waste management, we can refer to another scheme in which municipal waste management consists of 8 components: source reduction, generation, on-site storage, collection, transport, recycling, final disposal, and post-disposal handling (Fig. 3)   At the present time, for municipal solid waste management, a large part of financial and human resources are spent for collection and transport rather than in the field of generation, on-site storage, recycling, and disposal (Abduli, 1993).

**Source waste generation reduction:** Waste generation reduction is raised as the first component. According to Environment Protection Agency, it is "generation design and use of products, in the sense that it reduces the quantity and toxicity of generated waste when the lifetime of the products came to an end" (cited by Abduli, 1993). Waste generation control requires the implementation of programs such as high quality goods tailored to the needs of society, change in product packaging network, reusable recycling, and consumption reduction .There are a variety of waste reduction practices in the source of generation, the main types of them include:

- Reusing products
- Extending product durability
- Consumption with respect to product packaging
- Reducing the amount of toxicity in waste composition
- Reducing the size of waste through separation and recycling (Haj mohammadi et al., 2003).

**Waste generation:** Generation of solid unusable materials include actions that recognize the materials unusable and no longer being of value, for which they should be either thrown out or collected for disposal. Generation of materials is not currently controllable enough to be recognized as a constituting element in most circumstances.

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However, it is likely to exercise further control over material production in the future. Generation sources of municipal solid waste can be categorized in terms of the quality of generated materials;

- Household
- Commercial
- Industrial
- Health and sanitation
- Open regions
- Government offices
- Construction activities  (Rafati, 2005)

**On-site storage:** The stage following generation in waste management process is on-site storage. Storage stage refers to the time during which they remain in the area until municipal service officers come to remove and handle them (Rafati, 2005).

**Collection:** The stage following generation and storage in waste management process is waste collection. It begins with the removal of waste on site and lasts until the materials are released into disposal site. The maximum number of human resources and amount of financial resource for waste management at this stage are needed, which is why it plays a pivotal role in the management process (Abduli, 1993).  According to Abduli (1993), more than 90 percent of municipal waste in the country is collected through municipal waste management system. In larger cities, a mechanized system is also utilized. In some larger cities, private sector has expressed an interest in collecting municipal waste.

**Transport:** Transport includes the shipment of waste at transfer stations, or the transfer of the materials from smaller vehicles to larger vehicles at this station, shipping and handling them on final disposal sites. In these stations, there are places where trash is temporarily kept so that waste can be temporarily transferred there, and then released into large containers. Having been filled up, the containers are carried by vehicles called roll-off truck into final landfill site (Abduli, 1993).  According to World Health Organization, proper collection of waste in urban and rural areas would help to get rid of flies as much as 65% and to deal with rats, rodents without pesticides as much as 85%. It is also noteworthy that 80% of total municipal waste management costs is allocated to the collection and transport system. Unattractive landscape and environment pollution caused by lack of proper and timely collection of waste among instances are incorporated into multiplying the necessity for attending to such pressing matter in national waste management strategy (Fagan, 2005).Figure 4 shows different waste transport and collection management systems, which is essential to make plan for and implement them with respect to environmental conditions and urban fabric, quantity of waste, and above of all disposal site distance.

**Recycling:** Recycling refers to techniques and methods that based on it, some materials of waste which is usable is collected, separated, and employed as raw material to be produced for new products. The alternative is the best one to deal with solid waste, though it cannot solve municipal solid waste management issues by itself; however, it can obstruct the arrival of the main stream of materials coming to disposal centers. In other words, processing and recycling include the execution of a specific operation on solid waste in order to produce material and energy out of waste. Processing and recycling can be seen as a constitutive element along with other constitutive elements in the municipal solid waste management system, besides being embedded in other constitutive elements (Tchobanoglous et al, 1993).

It should be say that Iran undergoes industrial developments with population growth and urban development and is generator of pollutions required to be taken care of in developing strategy. Therefore, recycling operation devised a specific strategy for solid waste management due to invoking sanitary economic principles. The substitution of

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plastic which has been estimated to be 3 million pieces used in living instruments and released back into waste disposal sites after a while and caused detrimental repercussions for soil contamination, for which a successful recycling program can secure a great deal of economic interest to producers as well as bringing people special sanitary advantages (Suess, 1985). Figure 5 presents some essential items required to be dealt with in recycling from generation source.

Basically, it seems that integrating management and national solid waste organization into an exclusive department in direct contact with the Ministry of Interior should be planned and implemented. The experience of solving national water and wastewater problem by setting up a national water and waste water engineering company is a practice that can independently fulfill its obligations in relation to national solid waste under the name National Residual Cleaning and Engineering Company. Accordingly, an array of inconsistencies and duplications available on the current system of national waste will be brought to an end (Salvato, 1982).

## LITERATURE REVIEW

In this section, in light of the research topic, previous works are to be reviewed, and a number of conducted studies in the field of waste management will be pointed out. In a study conducted by Hokkanen et al (1995) in Uusimaa, Finland, A multicriteria decision-aid method, Electre II, was applied to the real choice process of a solid waste management system. According to them, this method recommends centralized incineration as the best municipal solid waste management system for the planning region. the second best alternative was intermediate RDF combustion with intermediate landfilling. Hokkanen and Salminen in1997 tested ELECTRE III decision-aid for choosing a solid waste management system. The method proved useful, especially when dealing with environmental problems involving many decision-makers. the solution recommended for a solid waste management system was intermediate landfilling, composting and RFD-combustion.

In another study carried out in Taipei in Taiwan by Hung et al. (2013) developed a sustainable decision making model for MSWM. The proposed model combines multicriteria decision making (MCDM) and a consensus analysis model (CAM). The CAM is built up to aid in decision-making when MCDM methods are utilized and, subsequently, a novel sustainable decision making model for MSWM is developed. The main feature of CAM is the assessment of the degree of consensus between stakeholders for particular alternatives. Ekmekçioğlu et al. (2010) proposed a modified fuzzy TOPSIS methodology for the selection of appropriate disposal method and site for municipal solid waste (MSW). In the first stage of the proposed methodology, a set of criteria of cost, reliability, feasibility, pollution and emission levels, waste and energy recovery was optimized to determine the best MSW disposal method. Landfilling, composting, conventional incineration, and refuse-derived fuel (RDF) combustion were the alternatives considered. The weights of the selection criteria were determined by fuzzy pairwise comparison matrices of Analytic Hierarchy Process (AHP). It was found that RDF combustion is the best disposal method alternative for Istanbul, Turkey. In the second stage, the same methodology is used to determine the optimum RDF combustion plant location using adjacent land use, climate, road access and cost as the criteria. The results of this study illustrate the importance of the weights on the various factors in deciding the optimized location. In Iran, Abduli et al (2011) compared the current solid waste management (MSW) strategies: landfill, and composting plus landfill. Life cycle assessment (LCA) was used to compare these scenarios for MSW in Tehran, Iran. The Eco-Indicator 99 is applied as an impact assessment method considering surplus energy, climate change, acidification, respiratory effect, carcinogenesis, ecotoxicity and ozone layer depletion points of aspects. According to the comparisons, the composting plus landfill scenario causes less damage to human health in comparison to landfill scenario. However, its damages to both mineral and fossil resources as well as ecosystem quality are higher than the landfill scenario. Thus, the composting plus landfill scenario had a higher environmental impact than landfill scenario. However, an integrated waste management will ultimately be the most efficient approach in terms of both environmental and economic benefits. Their Results show landfill scenario as the preferable option both in environmental and economic aspects for Tehran

in the current situation. Patil and Pokhrel (2005) assessed the waste handling and treatment system of hospital bio-medical solid waste and its mandatory compliance with Regulatory Notifications for Bio-medical Waste (Management and Handling) Rules, 1998, under the Environment (Protection Act 1986), Ministry of Environment and Forestry, Govt. of India, at the chosen KLE Society's J. N. Hospital and Medical Research Center, Belgaum, India. They observed that the process of segregation, collection, handling, and final disposal of infectious waste was done in compliance with Standard Procedures. Da Silva et al. (2005), evaluated medical waste management in the south of Brazil. A total of 91 healthcare facilities, including hospitals (21), health centers (48) and clinical laboratories (22) were surveyed to provide information about the management, segregation, generation, storage and disposal of medical wastes. The results about management aspects indicate that practices in most healthcare facilities do not comply with the principles stated in Brazilian legislation.

We can also refer to a work conducted by Bdour et al (2007) on quality and quantity of medical waste at medium to large size healthcare facilities located in Irbid city, Jordan. Results of the survey showed that healthcare facilities in Irbid city had less appropriate practices when it comes to the handling, storage, and disposal of wastes generated in comparison to the developed world. There were no defined methods for handling and disposal of these wastes, starting from the personnel responsible for collection through those who transport the wastes to the disposal site. Moreover, there were no specific regulations or guidelines for segregation or classification of these wastes. In addition to this, they claimed that there was no specific regulation on segregation and classification of medical waste. Now, considering the results of previous works, we can start discussion of the issue.

## RESULTS AND DISCUSSION

**The situation of MSW in the world (Istanbul, San Francisco, and Adelaide cities):**

**Istanbul city**: By setting environmental regulations and putting them on the agenda in 1991 (as the first version of "waste management control law") and subsequently revising it until 2005, some regulations were made to design and implement sanitary waste landfill and waste incineration sites in Turkey. However, the law is on the basis of three principles; waste disposal without damage to the environment, waste recycling, and waste generation reduction (Turan et al., 2009). The results showed that approximately 25 million ton of MSW are generated annually in Turkey. About 77% of the population receives MSW services. In spite of efforts to change open dumping areas into sanitary landfills and to build modern recycling and composting facilities, Turkey still has over 2000 open dumps (Turan et al., 2009). In recent years, MSW management in Istanbul has improved because of strong governance and institutional involvement. However, efforts directed toward applied research are still required to enable better waste management. Figures 6 shows situation of MSW in Istanbul and Figure 7 presents its components according to Kanat (2010).

**San Francisco city:** Encompassing a land area of about 121 km$^2$ and a population of 200,000 individuals, San Francisco initiated the United Nations Environment Program (UNEP), so it is viewed as a progressive city focusing on environmental issues combined with resource management in national and transnational dimensions. High convergence of the citizens of the city allows administrators to implement advanced and creative programs in the city. The qualities along with resourceful contractors in the field of collection, efficient service system, as well as calculation of handling, processing, landfill costs as stepwise procedures brought about increasing advances in the city (Naghizadeh, 2006). As the whole, the most important and effective methods in the process of MSW management in this city are as following:

Waste collection in an advanced fashion by "Recology Company" with an exclusive concession to provide waste management services (legally), which at this point in time it executed the mandatory recycling and composting law; that is, all residents and commercial sectors are required to segregate their wastes.

By setting up an environment department and a department of public affairs in collaboration with business sector owners and residents, various creative programs have been performed to design and implement an effective fair waste management system which is capable of handling special issues such as various street festivals holding up in the city.

A part of MAW were transferred to a landfill at a distance of 85 km., and other part transferred to Recology Company at a distance of 97km from the city in order to be turned into compost; however, in order to reduce high costs of handling and transportation, there are a number of discounts.

Average per capita waste generation in San Francisco is 1.7 kg per day, 72% of which is recycled, three-fourths of the remaining waste can be diverted through current implemented programs; the amount will reach 90% (Ludwig, 2003).

**Adelaide city:** One of the most advanced management in the field of waste can be found in the city of Adelaide, Australia which operated quite wisely with respect to environmental issues, such that 30 years ago the city took initial steps in this respect by passing container deposit legislation (CDL) for food packaging as well as taxes set. Because of high technology level in the city encompassing advanced and regulated procedures of waste management, which is an indication of their interest in protecting the environment. On the whole, the most important measures with respect to waste management include:

Resource management is considered one of the major policy-making priorities in this city. In July 2003, a new institution was founded in the government which is known as "Zero Waste South Australia" (ZWSA) in order to guide and implement waste reduction procedures, recycle, and reuse. One of the most creative aspects of the institution lies in the fact that its income directly depends on state government's income from landfill tax.

Automatic segregation and material compacting with the aim of transfer to processing and recycling centers and eventually exporting them to other countries are considered the most important part of the management.

Waste disposal in the city has been undertaken at the highest standard level of environmental protection over the years. On the contrary, the central policy of waste management in the city relies on waste diversion through imposing restrictions on the introduction of specific materials, landfill tax increase, and vast research and innovation programcost cover in the field of recycle and reuse.

Waste management in South Australia, particularly in Adelaide City, is one of the practical and successful kinds in this area. In South Australia, there is a broad will and consensus among politicians to create a stable legal and administrative system. Zero waste legislation and prevention of plastic bags are two typical excellent examples of leadership and executive powers of South Australia politicians through setting up institutionalized structures, economic mechanisms, and organizational capacities for achieving the main objective of waste management system. Table 2 shows MSW quantity in Adelaide city in 2010.

**The situation of MSW in Iran (Tehran city)**

In 1990s and 2000s, recycling of materials and energy from waste and MSWM organization in Iran led to a revision in former regulations and enactment of an act for all municipalities. Subsequently, following the expansion of cities and importance of municipal waste since the passing of waste management legislation in the Islamic Parliament in April 2004 (implementing regulations of the said Act in August 2005 were approved by the Cabinet), new phase of the optimization of the waste management status of national cities such as Tehran Metropolitan was started. According to this legislation, waste is divided into four main categories including garbage, hospital, agricultural, and industrial wastes, and cost of waste management is the responsibility of waste producers. In addition to this, according to

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Article 7 of Iranian waste management law, executive management can entrust all or part of operations relating to waste collection, separation, disposal to individuals and legal persons. Figure 8 shows the quantity of MSW in Tehran between 1991 and 2008. As can be seen, Waste generation is increasing in Tehran from 1991 to 1996. One of the most important reasons for this increase is the growth of private sector, and its activities during this period (Abduli and Azimi , 2010).

According to the census conducted in 2006, Tehran had a population of 7797520 individuals. According to the statistic, the per capita of waste generation was an average of 746 g per person.

In 2006, in Tehran Metropolitan, about 7449.7 tons of various wet and dry waste were generated per day, 231.19 tons of which (about 3%) were segregated at source, 909.6 tons (12.21%) of Tehran waste were converted into compost, and the residual amount which was equal to 6006.35 tons (81%) underwent a semi sanitary landfill. The data suggest that every Tehranian person averagely generate waste six times the weight of his body each year. Per capita daily waste generation in the world ranges from 250 g to 300 g, as it is 600 g and 1200 g in the north of Tehran (Abduli, 1995). Waste generated in the north part of Tehran is at least two times greater than its average at national level, and four times more than international standards according to the studies undertaken. The number of waste collection in Tehran is two or three times a day, as it is two or three times a week in the world. The available data indicate that per capita valuable waste generation in Tehran's municipal districts fluctuated between 4 and 238 kg in 2006.

## CONCLUSION

In this paper we reviewed Waste management process and its components in Iran and in the world, and discussed waste generation quantity and management in four cities of Istanbul, San Francisco, Adelaide, and Tehran, and compared the waste management process among them. With respect to the results, it was made clear that:

- Waste management methods in Iran are not in harmony with waste management criteria in advanced industrialized countries;
- Waste management methods in Iran are effective and efficient with respect to climate, culture, and geographical conditions;
- Geographical conditions have the highest effect on waste management process in Iran.

**Suggestions for improving MSWM in Tehran city**

In general, the following are recommended for municipal solid waste management in Tehran, respectively:Waste reduction: source reduction-related innovations (e.g. avoid, reduce, and reuse) are are seeking quantitative waste reduction at source through redesigning products or changing production and consumption patterns. Raising public awareness for citizens, modifying production and consumption structures, and encouraging industries to produce products with less waste after consumption are strategies for this project which require to be combined with creativity so that desired result be achieved.

Recycling: organizing, training, and equipment of valuable human resources, and employing them in recycling plants, presently is on the agenda, are effective measures on the verge of recycling system progress in Tehran. To make sure the projects of recycling and encouragement of private sector for public participation put into action is the economic efficiency of the projects that depends on the market of its products in the first place.

Composting: organic waste which is the major part of Tehran waste can be biologically processed in two methods; aerobic (composting) and anaerobic (digestion). The products of the former can be used in agriculture and other

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consumption, as for the latter generated gas (mainly methane) can produce energy. The use of the experiences of unsuccessful implemented projects for composting in Tehran as well as the study of successful instances in the developed countries can be regarded as effective steps in properly employing the method in Tehran's waste management system.

Incineration: waste incineration can reduce the size of waste by 90%. The reduction in size applies when major part of waste generation stream is made up of packaging materials, paper, cardboard, plastic, and horticultural waste. Under such circumstances, energy recovery from waste take priority over landfill, though environmental and economic issues should be accurately considered.

Landfilling: any material that remains as a result of previous processes or cannot be managed by them should be taken to landfill sites. Landfill should be engineered and principally designed in such a way that public and environment health receives no threat. Landfill gas (LFG) resulting from anaerobic disintegration of organic matter should be collected and can be applied to produce energy as well. To control landfill leachate, proper drainage should be performed, and collected leachate is required to be refined. Currently, the dominant method of waste disposal in Tehran is landfilling.

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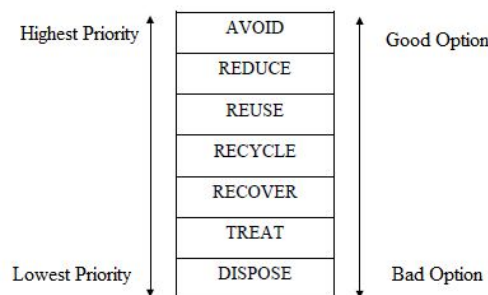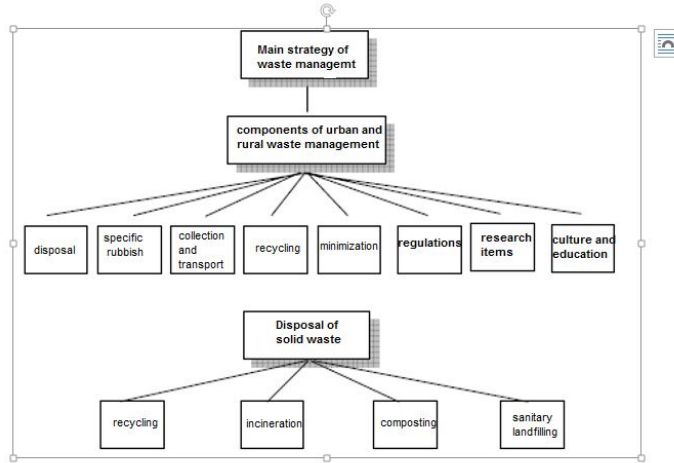
**Figure 1. Hierarch of solid waste management**

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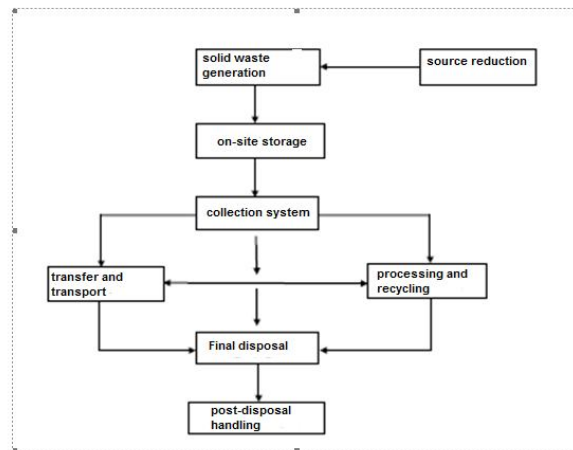**Figure 2. Main strategy of waste management**



**Figure 3. Components of solid waste management system**

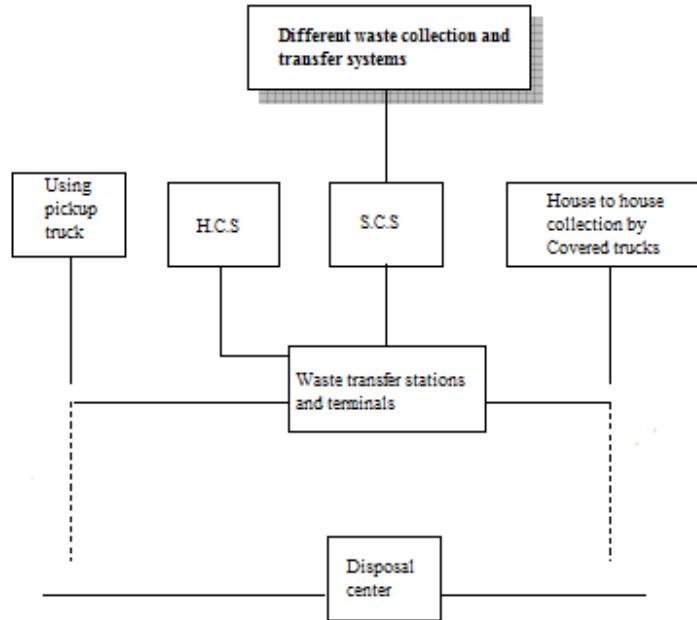**Farahizadeh *et al.***



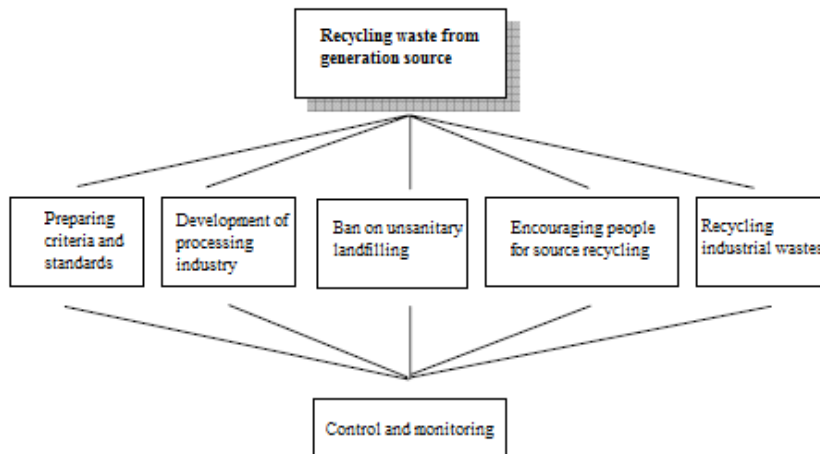**Figure 4. Waste collection and transport systems in many small cities of Iran**



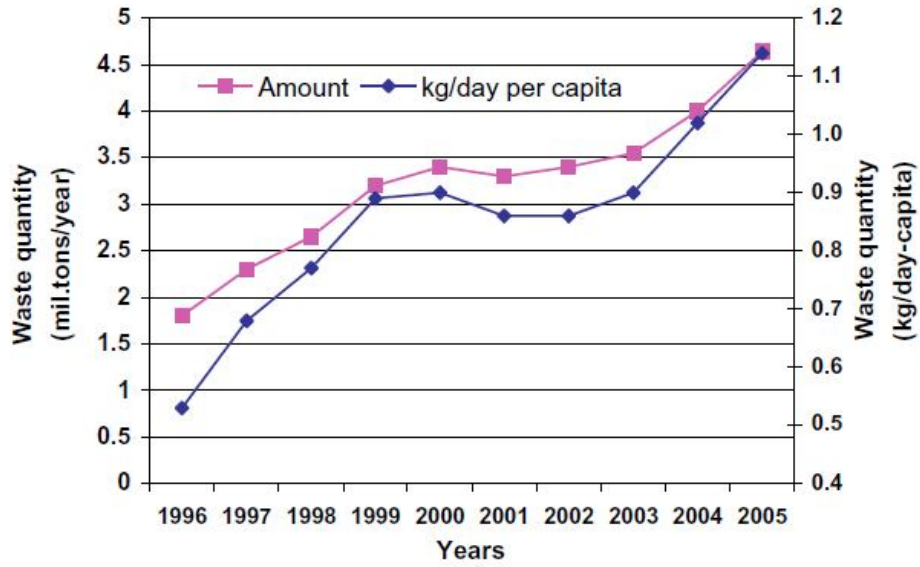**Figure 5. Waste recycling from generation source**

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**Figure 6. Amount of MSW in Istanbul between 1996 and 2005 (Kanat , 2010)**
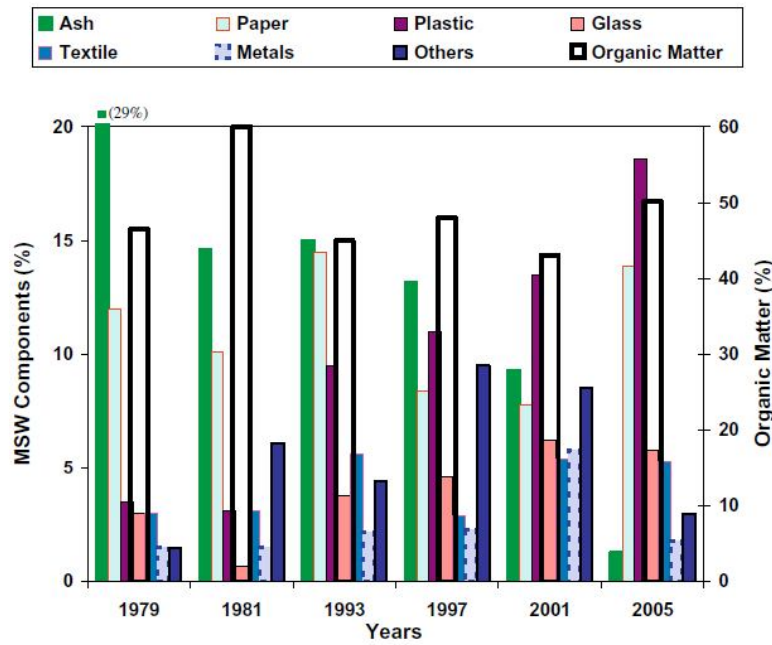


**Figure 7. MSW Components in Istanbul during 1979-2005 (Kanat , 2010)**
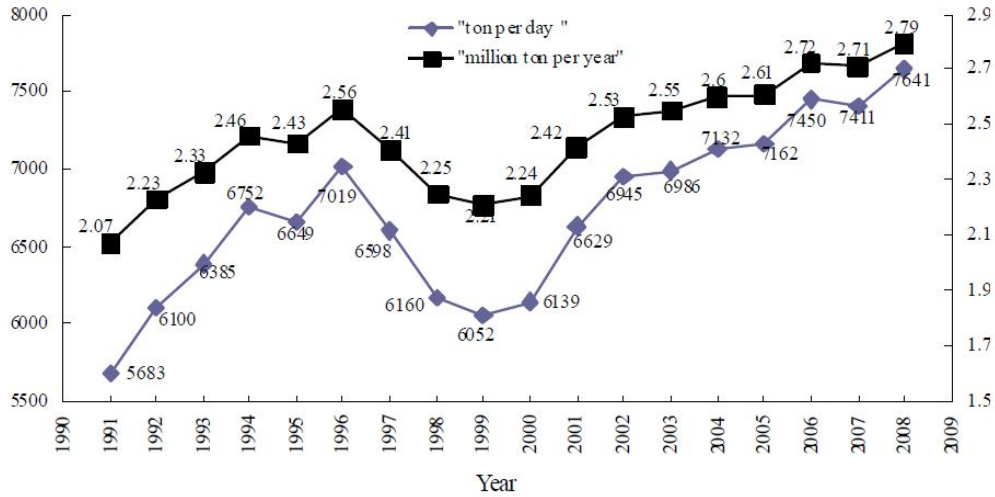
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**Figure 8. Total solid waste generation in Tehran during 1991 to 2008 (Abduli and Azimi, 2010)**

**Table 1. MSW quantity in San Francisco (UN-Habitat, 2010)**

| Total MSW in each year (Kg per year) | 508323 tons |
|---|---|
| Annual generation | 609 kg |
| Coverage percentage | 100% |
| Disposal percentage | 28% |
| Incineration percentage | Almost zero |
| Diverted MSW percentage | 72% |

**Table 2. MSW quantity in San Francisco (UN-Habitat, 2010)**

| Total MSW in each year (Kg per year) | 742807 tons |
|---|---|
| Per capita | 490 kg |
| Coverage percentage | 100% |
| Disposal percentage | 46% |
| Incineration percentage | 0% |

**RESEARCH ARTICLE**

# The Design of Residential Complex with an Approach to Promoting Residents'vitality (Case Study: Atisazshahindezhresidential Complex in Tehran)

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**ABSTRACT**

Today, vitality and happiness are the missing links in urban life. This fact is especially more important in residential complexes. In this regard, taking into account only the quantitative aspects of organizing the space as well as having a one-dimensional look to it have decreased quality of most of public spaces in the residentialcomplexes. Social vitality in today's society is one of the needs and necessities and lacking it in the community results in many problems. This research investigates the relationship between environmental qualities and vitality of residential complexes in Tehran, aiming at the creation of public spaces in which people have active participation in various activities. The vitality factors of the residents of AtisazShahindezhresidential complex of Tehran were identified and then classified using questionnaire, interview and field observations and then, factors required for the design of vital residential complex were identified. Afterwards, the collected data were analyzed and based on the results of the analysis a new plan for designing the residential complex with an approach to enhancing the vitality of the residents was proposed. In this study, the sample size was 167. To determine the reliability of the questionnaires, Cronbach'salpha coefficient was used. The research's methodology is descriptive-analytical and the collected data were described and analyzed using questionnaire, SPSS and statistical techniques such as frequency distribution, Pearson correlation coefficient and multiple regression.

To answer the research's questions, six hypotheses were presented. The results of this study indicated a correlation between residents' freshness and vitality from one hand and mixed land uses, diversity of

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users, e.g. women, children, the elderly, and so on, diversity of materials, forms and colors, diversity of behavioral settings, green spaces and physical permeability from the other hand.

**Key words**: residential complex, vitality, vivacious, quality, AtisazShahindezhresidential complex

## INTRODUCTION

Social vitality in today's society is one of the needs and necessities that lacking it faces the society with problems. Some residential areas of present-day cities of Iran for various reasons are less vital and citizens have unhappy and dejected spirits. Whereas the residential neighborhoods of traditional cities had vivacious and joyful environments, in which we could see considerable presence of people and their diversity (in terms of age and gender) in a wide range of daytime that were doing mostly optional or social activities. The lack of vitality and dynamism of neighborhood and its dismal nature is an issue needing appropriate and innovative solutions (Norouzian, 1390: 2).

Today, taking into account only the quantitative aspects of space designs having a one-dimensional look to it has decreased the quality of most public spaces in the neighborhood areas. The lack of wide and holistic view in space planning and design has caused these spaces lack the necessary vitality, vivacious, freshness and dynamism. Meeting the social needs of peopleand providing needed opportunities in the field of acquiring social experience requires the presence of physical space and public spaces have great potential for responding to this aspect of human's life. The lack of appropriate public spaces in the neighborhood areas has decreased the possibility of communicating with humans, rest, walk, watch, leisure, game, gatherings, meetings, conversation, etc. for everyone, whereas, public spaces canmake necessary opportunities for creating social interactions. When people interact with each other, feel a stronger relationship with their location and their community (Norouzian, 1390: 3).

### Problem statement

Today, for various reasons, providing vitality and freshness in environments has become one of the main concerns of urban management system. Providing vitality in environment as a legitimate goal can be seen at the top of many official documents of urbanism, which in turn is arisen from the importance of space vitality as a goal and a tool (Golkar, 1385).

Public spaces in residential neighborhoods provide various opportunities to experience the joy and vitality for citizens. The experience of happiness in a neighborhood park, in a sports space, in a cultural environment, in an open space or at a festival of joy are various happy experiences. Social events, type ofactivities and uses within spaces as well astheir ability in attracting various people and groups is the most important factor in the dynamism of public spaces and its activity in different hours and seasons. The assessment indicatorfor this dimension is the amount and frequency of visiting of people from space and their participation in various activities (Norouzian, 1390).

### Research objectives

Defining goals for each study makes clear the framework in which the research should be conducted. The objectives that the present study seeks for are follows:

**The main objective**: present study expresses architectural solutionsfor enhancing the vitality of the residents of the residential complexes.

**Subsidiary objectives**: with respect to the mentioned main objective, the subsidiary objectives are as follows:

Defining the role of view in creating vitality in residential complexes
Recognition of the role of public spaces in the creation of vitality in residential complexes
Explaining the role of open spaces in creating vitality in residential complexes

## LITERATURE REVIEW

Since 1960, with the establishment of "environmental psychology", taking into account the human qualities in the design of public realms and their impacts on further use of spaces by use become important so that people like "Kevin Lynch", "Eyen Bentley","Charles Landry" and others proposed measures to improve this environments.

### Research's questions or hypotheses

The main question of research is what are the architectural solutions for improving vitality in residential complexes?
The subs questions are as follows:
What is the role of building's facade in creatingvitality in residential complexes?
What is the role of public spacesin creating vitality in residential complexes?
Are residential open spaceseffective in creating vitality in residential complexes?

## METHODOLOGY

This research is descriptive-analytical and its methodology is survey. The data collection tool was questionnaire.

**Research questions**: this study examines 54 questions that are related to research's hypotheses.To analyze the questions SPSS was used.

**Validity and reliability of questionnaire**: the questionnaire's validitywas confirmed during three stages of data collection based on consulting with experts. To determine the reliability of questionnaires, Cronbach's alpha coefficient was used, which its results for each of the indicators is calculated separately.Cronbach's alpha for questionnaire is 0.868.

**Population**: the population of study includes all residents of AtisazShahindezhcomplex.

**Sample size**: sample size using Morgan's tablewas determined equal to 186 subjects. To ensure of the minimum samplesize, i.e. 186, we distributed 230 questionnaires (with the loss possibility of 20%). Selecting the sample size equal to 167, this research can have enough volume for judgment.

### Concepts, perspectives and theoretical foundations

### Definitions

### The concept of vitality

Vitality literally means joy, happiness, exhilaration, gaiety, etc. The word vitality in Persian dictionary is defined as verve, lightness, vivacity, agility, happiness, joy, and so on (Dehkhoda, 1373).

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Happiness and vitality are closely related to each other so that vitality can be considered as a source of happiness (TamimiAmadi, 1381). Although these twowords often are used interchangeably, there are differences between these two psychology statuses, which are less considered. The difference is that happiness accompanies with laughter and smiles, but vitality is type of joy that results in willingness to work and appears in the form of activity and bustle (Norouzian, 1390).

In urban culture of Robert Cowan, the words vitality and viabilityare presented next to each other. They are properties of successfulsmall and large cities. Vitality refers to busy nature of city in different times of the day and in its different sections, whereas viability refers to the cities' measurement capacityfor absorbing capital for survival, improvement and adaptation with the changing needs (Cowan,1387:442). In fact, cities' vitality includes levels of activity (what are happening), participation and use levels, levels of interaction, communications, transactions, and levels of representation (how activities and interactions appear and are discussed in the outside world) (Khastoo, 1388).

In public culture, vitality sometimes is confused with the busy and crowded space of city. However, a very vital urban space is not necessarily very busy, or vice versa. Viability occurs in an atmosphere where people are working to provide their basic needs and their activities are mainly necessary, e.g. going to work and daily purchases, whereas vitality of space is a result of social and optional activities. In other words, we can say that the number of people in a space and theirquantitative features do not represent the vitality and livability of space but the quality of people and type of theiractivities determine the amount of vitality of space (Khastoo, 1388).

In general, the concept that in this study will be considered as the vitality refer to a vibrant, attractive and dynamic space in which citizens of all ages groups and from all categories with the main objective spending their leisure have a of constant and significant presence in the environment. The main feature of this presence is that it is an optional and social presence and not forced and urgency. Since the aim of this study was to create vitality in the residential complexes, the concept of vitality in the micro scale (urban environment) is being considered. In this line, it will tried finally by taking appropriate executive policies and strategies provide the bed for the presence of many people that differ in terms of age, sex and so on in an urban environment in a wide range of daytimeso that their activities are mainly optional and social. It is obvious that the mentioned vitality when combining with concepts such as justice, efficiency, adaptability, flexibility, environmentquality, safety, security, and so on will result in city's viability (Razavi, 1392: 15).

**Explaining measures of vitality from the viewpoint of theorists**

Jacobs in the book of "The Death and Life of Great American Cities," published in 1961, defines the street as a location of the occurrence of communications and contact between people and where people watch each other. Jacobs stated four basic conditions for creating diversity in urban areas and streets and as a result for urban vitality. These conditions includedcreating mixed land uses, the necessity of creating short urban blocks, the necessity for presence of the old buildings, the necessity of the concentration of population (Jacobs, 1386).

He speaks in the first condition about diversity of land uses, in the second and third conditions about the physical diversity, and in the fourth conditions about the diversity of activities. In fact, as he believes, diversity leads to vitality, land uses createactivities, and in the case of various land uses, diversity people at different hours of the day would increase certainly. So, one of the requirements for environmental vitality is existence of different uses and their diversity (Norouzi, 1390).

Jan Gehlin is his definition about vitality in the book of "Life between Buildings" proposes four criteria for identification and creation of vibrant spaces. These criteria are as follows: frontage and appropriate communication

between activities inside and outside the buildings, observing the human scale of spaces, considering the quality of the design and avoiding bright and glassfacades because they provoke of the sense of non-inviting to space.

Quenched Lynch in his book about Theory of the City, published in 1981, investigated the vitality in large-scale and he believes that vitality along with 6 other factors, including meaning, relevance, access, oversight and authority, efficiency, and justice, constitute the functional aspects of a good city. He defined vitality as the extent to which the form of place supports the performance, life needs and human capacities. According to Lynch, a vital environment is a good settlement environmentthat provides the health and wellbeing of people as well as the survival of living creatures.According to him, three main features of the environment that affect the health and creation of a vital environment and a suitable bed for life are as follows: "survival", "safety" and "compatibility" (Lynch, 1384).

KouroshGolkar in his articleabout creating a vitaland vibrant environment using help urban design defines the urban vitality as a concept in the field of urban design and believes that vitality along with sixteen other qualities create a phenomenon called urban qualitydesign. The other sixteen qualities that Golkar refer to as requirements for urban design's quality are as follows: quality of legibility, visual character, goodness of time, sensory richness, dependency rust, edifying, permeability and motion, mixed land uses and form, inclusiveness, quality of public areas, climatic comfort, safety and security, flexibility, harmony with nature, efficiency energy and environmental cleanliness. These qualities make a phenomenon called urban design.Golkar to evaluate the vitality of urban spaces, especially in the micro scale, suggested a number of indicators as follows: the concentration of pedestrians in region, the number, diversity and nature of existing behavioral settings, seasonal activities, urban pace, diversity of users (male, female, young, old, children, disabled, etc.) and diversity of form and color in city's perspective.

JahanshahPakzadin one of his studies investigated and examined the criteria and characteristics of vitality in coastal environments. Although these criteriaare further suitable for the beach spaces, its comprehensiveness was to the extent that can be generalized to other urban areas too (Razavi, 1392: 60).Pakzadexamined the diversity in term of two dimensions, i.e. body and performance, and suggested that for promoting diversity in urban streets, the following factors should be observed:

- creating facilities for leisure,
- creating public facilities like public parking, public phone, etc.,
- creating active facilities during the night,
- good dispersion of facilities that are active during the night,
- providing security in the streets,
- presence of different people from diverse groups,
- diversity in urban environments,
- establishment of furniture consistent with the presence behaviors in the space, and
- the use of various social and welfare facilities (Pakzad, 1384: 140-143).

Hussein Bahraini believes that the quality and vitality of urban spaces results from attracting different people with diversity of age, gender and socio-cultural characteristics and different needs in urban environments. This aim does not happen by diversifying the urban environments. Bahraini proposes the following measures for diversity in urban environments: diversity and optionality in general, mixed activities, mixed housing and business, variability in transport networks, variability in emotional experiences, diversityin housing type, accessibility from anywhere,diverse open spaces, various activities and traditions, and various styles (Bahraini, 1383, pp. 215-216).

Architects Association of the United Statespublished a series entitled "vitality" in 2005 about vitality in the micro-level. In addition, we cannot propose a clear definition for vitality and vitality of a placeshould be defined and

determined considering the characteristics of the place and its inhabitants. General sense of the vitality of a place is associated with identity, dynamism, flexibility and adaptability with new requirements (www.aia.org).

The association proposed the following indicators for vitality in the urban environment:

- observing the human principles in designs,
- providing various and diverse options for residence,
- shopping, entertainment and promoting mixed uses,
- provide a diversity of travel options including walking, biking, the use of public transports, and private cars,
- creating recognizable and acceptable public places,
- creating identity, sense of place and unique character,
- protecting green and open spaces as well as natural elements, and
- observing the high quality of design in single buildings (Razavi, 1392, p. 62).

Matthew Carmona et al. (2003) in a recent work classified the physical qualities of environment in a study aboutpublic places and urban spaces. In this work, Cremona classified impressive qualities on the physical environments into five categories: access, hard space and soft space, public space, safety and security, urban landscape, mixing and compaction, inclusiveness, time management of space (Carmona, 2003). Analogously, in the categorization by Matthew Cremona et al., five mixing items (activity diversification) and time management of space (availability of 24 hours a day facilities) directly affect the vitality in urban spaces.

According to William White, new cities are too planned and engineered and thus they lack life and vitality. White introduced the street life project in 1970 and made his first experience inparks, playgrounds and unofficial recreational spaces of New York Citythat are almost empty of population. However, the placement of these places in the neighborhood of very densely populated areas showed that such places against some streets had not considerable attractiveness for people. According to him, the presence of large groups of people indicatesthe superiority of space (Pakzad, 1389: 423).

- Barton to create construction in urban areas suggested the following criteria:
- increasing the flow of pedestrians and providing public transport networks,
- visibility and visual permeability as well as flexibility of uses,
- existence of micro businesses and active jointed frontages of shops,
- making mixed uses and increasing diversity of businesses and non-commercial uses, and
- creating interconnected networks of green spaces (Razavi, 1392).

According to the literature, we summarized indicators that were derived from vitality indicators proposed by different theorists in Table (2-1). Some theorists have some vitality indexes in common. In this study, we have examined measures that theorists have put more emphasis on them and are suitable in responding to questions about the research. During the development of a questionnaire including the content of these indicators, we asked for the residents'comment on these indicatorsand contributions of these indicatorsin the prediction of vitality changes in the residential complexes that areexplanation in the following in detail.

This study to answer the survey questions examines indicators about (1) mixed land uses, (2)diversity of users (women, children, the elderly, etc.), (3)diversity of form and color, (4) the number, diversity and nature of existing behavioral settings, (5)Protecting the green and open spaces and natural elements, (6) physical and visual permeability. First, we try giving answers to questions about the role of facade and public and open spaces as well as

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we examine the influence of these factors on the vitality of residential complexes. Then, solutionsin connection with each of the indicators will be addressed.

According to the above-mentioned cases, in the current study, Cronbach's alpha stabilization method is used, which according the obtained result ($\alpha = 0.868$) is higher than the minimum allowed value in the Social Science Research ($\alpha > 0.7$) and general minimum allowed value ($\alpha > 0.5$). Thus, the present study meets the needed credit for generalizing the research's data.

## FINDINGS

In the present paper, sample size was 167 people, of which 40% were female, 60% were male and the age distribution of respondentsofthe research, which was questioned in terms of 54 questions, was in terms of 10-year-old age group. Majority of respondents had abachelor degree, which with 40% constitutes the maximum part of the sample. Demographic characteristics of the sample are presented in table (3-1).

In the present study, data collection tool was questionnaire. Vitality index with 18 items, index of mixed- use with 5 items, index of green space with 7 items, index of diversity of users with 5 items, index of behavioral settings with 5 items, index of diversity of materials and colors with 6 items and index of physical and visual permeability with 8 items were presented for the respondents. Questions are five-options, which were valued from 1 to 5. In table (3-2), the average values of respondents'answersare presented.

As can be seen in the table, among the factors affecting the vitality and happiness of residents of residential complexes, three factors of green spaces and waterfronts, mixed land uses and various behavioral settings have the highest average; whereasfactors the diversity of materials, color, and form and physical and visual permeability have the lowest average.

In the second part of the study, the data were analyzedusing the inferential statistics.

**Checking the normality of the distribution of data**

In order to determine the normality of the distribution of data, the Kolmogorov-Smirnov (k-s) was used and the results are presented in the table below.

According to Kolmogorov-Smirnov test, the significant level of the distribution of data relevant to variables users'diversity and physical and visual permeability are less than 0.05, so,their distribution is not normal. As a result, to analyze data related to these two variables, the nonparametric statistical methods were used. The above table also shows that the significant level of other variables is greater than 0.05 and thus the distribution of data are normal. As a result,to analyze data related to these variables, parametric statistical methods are used.

**Checking correlation between the variables**

In the following, research's hypotheses are presented.

**Hypothesis 1**: There is a significant relationship between the factor of mixed land uses and residents'happiness and vitality.

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The results of the Pearson correlation coefficientin table (3-4) showssignificant relationship between the factor of mixed land uses and residents' happiness and vitality and thus the first hypothesis is confirmed.

**Hypothesis 2**: There is a significant relationship between green space and waterfront with residents'happiness and vitality.

The results of the Pearson correlation coefficientin table (3-5) showssignificant relationship between the factor of green space and waterfront and residents' happiness and vitality and thus the first hypothesis is confirmed.

**Hypothesis 3**: There is a significant relationship between diversity of users with residents'happiness and vitality.

The results of the Pearson correlation coefficientin table (3-6) showssignificant relationship between diversity of users and residents' happiness and vitality and thus the first hypothesis is confirmed.

**Hypothesis 4**: There is a significant relationship between various behavioral settingswith residents'happiness and vitality.

The results of the Pearson correlation coefficientin table (3-7) showssignificant relationship between the factor of various behavioral settings and residents' happiness and vitality and thus the first hypothesis is confirmed.

**Hypothesis 5**: There is a significant relationship between diversity of materials, colors and forms with residents'happiness and vitality.

The results of the Pearson correlation coefficientin table (3-8) showssignificant relationship between diversity of materials, colors and forms with residents' happiness and vitality and thus the first hypothesis is confirmed.

**Hypothesis 6**: There is a significant relationship between physical and visual permeability with residents'happiness and vitality.

The results of the Pearson correlation coefficientin table (3-9) showssignificant relationship between physical and visual permeability and residents' happiness and vitality and thus the first hypothesis is confirmed.

**Friedman test results**

To rank architectural factors influential on residents' vitality and happiness of residential complexes, the Friedman test was used, which its results are presented in Table (3-10).

According to the above table, Friedman test results showed a significant relationship at the confidence level of 99% ($p \leq 0.01$)between factors affecting the vitality and happiness and of residents. Accordingly, these factors can be ranked. As can be seen in the table above, from the perspective of residents of the residential complexes, green space and waterfront had the highest rank followed by mixed-uses, various behavioral settings, diversity of users, visual and physical permeability, diversity of materials, color, and form, in order.

In the following, the rankingof indicators of each of the six architecture factors was done using Friedman test, which is presented in the following.

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According to Table (3-11), Friedman test results showa significant difference between indicators of mixed land use (p≤0.01). Accordingly, these indicatorscan be ranked. The results show the index of availability of sports and recreation spaces has the highest rank.

According to Table (3-12), Friedman test results showa significant difference between indicators of green space and waterfront (p≤0.01). Accordingly, these indicatorscan be ranked. The results show the index of cultivations of different flowers has the highest rank. According to Table (3-14), Friedman test results showa significant difference between indexes of users' diversity (p≤0.01). Accordingly, these indicatorscan be ranked. The results show the index of presence of youth has the highest rank.

According to Table (3-14), Friedman test results showa significant difference between indexes of diverse behavioral settings(p≤0.01). Accordingly, these indicatorscan be ranked. The results show the index of availability of spaces for collective activities such as walking has the highest rank.

According to Table (3-15), Friedman test results showa significant difference between indexes of diversity of materials, colors, and forms (p≤0.01). Accordingly, these indicatorscan be ranked. The results show the index of using different colorshas the highest rank.

According to Table (3-15), Friedman test results showa significant difference between indexes of visual and physical permeability (p≤0.01). Accordingly, these indicatorscan be ranked. The results show the index of creating green spaces in the entrance of complexes has the highest rank.

**Results of multiple regression analysis**

In order to determine the effectiveness of each of the effective architectural elementson the vitality and happiness of residents, the multiple regression analysis was used and the results are presented in Table (3-17).

The results of stepwise regression analysis show that in the first step, the factor of diversity of users with the regression coefficient of 0.316 can predict 31.6% of variations in happiness and vitality of residents of residential complexes. In the second step and with the addition of mixed land use factor, these two factors can predict 37.4% of variations of residents' happiness and vitality. In the third step, and with the addition of the factor of materials, color and form to the two previous factors, the three factors together can predict 40.5% of variation in the happiness and vitality of the residents. According to the analysis done by AtisazCompany, the reasons for these low percentages are as follows.

# CONCLUSION

According to the description and analysis of the collected data form AtisazShahindezh residential complexes, the importance of independent factorsis as follows: (1) green space and fountain, mixed land uses, diverse behavioral settings, diversity of users, physical and visual penetration, diversity of materials, and color. Among the mentionedfactors, diversity of users, mixed uses and the diversity of colors and materials predict 40.5% of variations in vitalityvivacious of the residential complexes. Due to the quantitative looking to the green space and behavioral settings as well as neglecting the quality of these spaces, these factors have failed in creating vitalityfor the residents of AtisazShahindezhcomplex. For example, the dense trees in the area have made visual and physical permeability factor more colorless and the slope of the site despite the dense trees is another factor for reduced physical and visual permeability. Separate attention to quantitative standards and ignoring quality standards has prevented the strengthening and formation of the sense of vitality among residents of AtisazShahindezhcomplex.

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Green space is the first and the most important factor in creating vitality for the residents and so, quantitative attention to this factor is not enough. In other words, in the design of this factor in addition to cultivating flowers, big trees, lawn, and having awning,waterfront, vegetable garden, fruit trees, and statues, we should also take into account the quality, location and the number of these factors carefully.

Mixed-use factor is associated with variables such as sports and recreational spaces, children places, cultural and educational spaces, service spaces, and religious spaces.Diversebehavioral settings factor is correlated with variables such as the existence of walking paths, sitting spaces, meeting and dialoguespaces, collective movies watching spaces, and the meeting spaces.About the diversity factor of users, respondents to the questionnaire introduced factors such as the presence of youth, women, children, men and the elderly as factors leading to the vitality.

The factor of physical and visual permeabilityis correlated with variables of creating green spaces in the complex entrance, easy access to outdoor, spaces between public and private spaces (observing the hierarchy), presence of transparent walls, low number of floors, and retreat in the entrance of complex.

About the factor of diversity of colors and materials, respondents emphasized on the diversity of colors and materials in materials used in the design of facades and they did not supported the use of a single color or one type of material.

In the following, the results indicated that green space and diversity in color and material are the most important and the least important factors, respectively. It is hoped that in the future designing quality green spaces be placed at the top priority of designers' work so that the green space as the most important factor cause increased sense of vitality in the residential complexes.

Despite the density and volume of construction in Tehran, no standard in this regard is developed yet. Therefore, we suggest for the further research,examiningstandardization of available green spaces in the residential complexes and examining designs and solutions of residential complexes with more detail in the form of case studies.

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**Table 1: Cronbach's alpha coefficientfor questionnaire's variables**

| Variable | Number of items | Cronbach's alpha coefficient |
|---|---|---|
| Freshness and vitality | 18 | 0.86 |
| Mixed land uses | 5 | 0.70 |
| Green space and waterfront | 7 | 0.77 |
| Users' diversity | 5 | 0.76 |
| Various behavioral settings | 5 | 0.75 |
| Diversity of materials, colors and forms | 6 | 0.71 |
| Visual-physical permeability | 8 | 0.70 |

**Table 2: Description of vitality measures from the viewpoint of theorists**

| Vitality indicators derived from literature / Theorists | Jacobs | Gehl | Lynch | Golkar | Pakzad | Bahraini | United States' association of architects | Matthew Cremona | Chapman | William White | Barton | Frequency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mixed land uses | * | | | | | * | * | * | | | * | 5 |
| Creating short urban blocks | * | | | | | | | | | | | 1 |
| Presence of old buildings | * | | | | | | | | | | | 1 |
| Necessity of populationcentralization | * | | | * | * | | * | * | * | | | 6 |
| Diversity of Users (Women, children, the elderly, etc.) | | | | * | * | * | | | | | | 3 |
| Diversity of form and color in urban landscape | | | | * | * | * | | | | | | 3 |
| Seasonal activities | | | | * | | | | | | | | 1 |

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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number, diversity and nature of available behavioral settings | | | * | * | * | * | * | | * | | 6 |
| Attention to the quality of design | * | | | * | | * | | | * | * | 5 |
| Observing human scale of spaces | * | | | | | | | | * | * | 3 |
| Proportionality of access | | * | | | * | * | | * | | * | 5 |
| Oversight and authority | | * | | | | | | | * | | 2 |
| Efficiency | | * | | | | | | | | | 1 |
| Justice | | * | | | | | | | | | 1 |
| Security | | | | * | | | | | | | 1 |
| The use of different social and welfare facilities | | | | * | | | | | | | 1 |
| Buildings and active frontages towards the street | * | | | | | * | * | | | * | 4 |
| Diversity in open spaces | | | | | * | | | | | | 1 |
| Protecting the green and open spaces and natural elements | | | | | | * | | | | * | 2 |
| Physical and visual permeability | | | | * | | | | | * | * | 3 |
| Making facilities flexible | | | | | | | | | | * | 1 |
| Diversifying housing type | | | | | * | | | | | | 1 |

**Table 3: Demographic characteristics of the studied sample**

| Demographic \ Property | Categories | Frequency | Percent |
|---|---|---|---|
| **Gender** | Male | 100 | 60 |
| | Female | 67 | 40 |
| **Age** | < 20 | 18 | 11 |
| | 21-30 | 50 | 30 |
| | 31-40 | 30 | 18 |
| | 41-50 | 21 | 12.5 |
| | 51-60 | 27 | 16 |
| | 60 years | 21 | 12.5 |
| **Education level** | Lower Diploma | 17 | 10 |
| | Diploma | 42 | 25 |
| | Associate Degree | 22 | 13 |
| | Bachelors | 67 | 40 |
| | Masters | 19 | 11 |
| **Maritalstatus** | Single | 55 | 33 |

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| | Married | 112 | 67 |
|---|---|---|---|
| **Number of Children** | 0 | 77 | 46 |
| | 1 | 19 | 11 |
| | 2 | 43 | 26 |
| | ≥ 2 | 28 | 17 |

**Table 4: Standard deviation and average of research's variables**

| Variable | Number | Average | Standard deviation |
|---|---|---|---|
| The sense of vitality and happiness | 167 | 3.42 | 0.582 |
| Mixed-use | 167 | 4 | 0.634 |
| Green space and waterfront | 167 | 4.06 | 0.650 |
| Diversity of users | 167 | 3.6 | 0.737 |
| Various behavioral settings | 167 | 3.96 | 0.679 |
| Diversity of materials, colors and forms | 167 | 3.17 | 0.565 |
| Physical and visual permeability | 167 | 3.34 | 0.526 |

**Table 5: Kolmogorov-Smirnov (k-s) test to determine the normality of the distribution of data**

| Variable | Count | Significance level | $Z_{ks}$ | Result |
|---|---|---|---|---|
| The sense of vitality and happiness | 167 | 0.108 | 1.207 | Normal |
| Mixed-use | 167 | 0.058 | 1.332 | Normal |
| Green space and waterfront | 167 | 0.137 | 1.158 | Normal |
| Diversity of users | 167 | 0.023 | 1.497 | abnormal |
| Various behavioral settings | 167 | 0.060 | 1.325 | Normal |
| Diversity of materials, colors and forms | 167 | 0.097 | 1.229 | Normal |
| Physical and visual permeability | 167 | 0.012 | 1.594 | abnormal |

**Table 6: The relationship between mixed-uses with the sense of vitality and happiness**

| Independentvariable | Dependent variable | Correlationcoefficient | Significance level | Result |
|---|---|---|---|---|
| **Mixed land use** | **Vitality and happiness** | 0.334 | 0.001 | Confirm |

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**Table 7: The relationship between green space and waterfront with the sense of vitality and happiness**

| Independentvariable | Dependent variable | Correlationcoefficient | Significance level | Result |
|---|---|---|---|---|
| **Green space and waterfront** | **Vitality and happiness** | 0.255 | 0.01 | Confirm |

**Table 8: The relationship between diversity of users with the sense of vitality and happiness**

| Independentvariable | Dependent variable | Correlationcoefficient | Significance level | Result |
|---|---|---|---|---|
| **Diversityof users** | **Vitality and happiness** | 0.456 | 0.001 | Confirm |

**Table 9: The relationship between various behavioral settings with the sense of vitality and happiness**

| Independentvariable | Dependent variable | Correlationcoefficient | Significance level | Result |
|---|---|---|---|---|
| **Various behavioral settings** | **Vitality and happiness** | 0.254 | 0.001 | Confirm |

**Table 10: The relationship between diversity of materials, colors and forms with the sense of vitality and happiness**

| Independentvariable | Dependent variable | Correlationcoefficient | Significance level | Result |
|---|---|---|---|---|
| Diversity of materials, colors and forms | **Vitality and happiness** | 0.393 | 0.001 | Confirm |

**Table 11: The relationship between physical and visual permeabilitywith the sense of vitality and happiness**

| Independentvariable | Dependent variable | Correlationcoefficient | Significance level | Result |
|---|---|---|---|---|
| Physical and visual permeability | **Vitality and happiness** | 0.180 | 0.020 | Confirm |

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**Table 12: The ranking of factors affecting the vitality and happiness of residents**

| Sample size | 167 | Factors | Rank | Average Rank |
|---|---|---|---|---|
| | | Green space and waterfront | 1 | 4.58 |
| | | Mixed-use | 2 | 4.34 |
| | | Various behavioral settings | 3 | 4.33 |
| | | Diversity of users | 4 | 3.24 |
| Chi-Square | Various behavioral settings | Physical and visual permeability | 5 | 2.45 |
| Degrees of freedom | Diversity of materials, colors and forms | Diversity of materials, colors and forms | 6 | 2.06 |
| Significance level | 0.001 | | | |

**Table13: The ranking of indexes of mixed-use factors**

| Sample size | 167 | Index | Rank | Average Rank |
|---|---|---|---|---|
| | | Availability of sports and recreation spaces (pool, sauna, gym, etc.) | 1 | 3.62 |
| | | Availability of spaces for children (children's playground, kindergarten, etc.) | 2 | 3.20 |
| | | Availability of cultural and educational spaces (library, study hall, classes, etc.) | 3 | 2.88 |
| Chi-Square | 75.285 | Availability of service spaces (supermarket, bakery, hairdresser, laundry, etc.) | 4 | 2.77 |
| Degrees of freedom | 4 | Availability of religious places (mosques, Hosseinieh, etc.) | 5 | 2.54 |
| Significance level | 0.001 | | | |

**Table 14: The ranking of indexes of green space and waterfront**

| Sample size | 167 | Factors | Rank | Average Rank |
|---|---|---|---|---|
| | | Cultivations of different flowers | 1 | 4.89 |
| | | Cultivations big trees having shade | 2 | 4.40 |
| | | Lawn cultivating | 3 | 4.34 |
| | | Water and waterfront | 4 | 4.18 |
| | | Vegetable garden | 5 | 3.81 |

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| Chi-Square | 159.99 | Fruit trees | 6 | 3.56 |
|---|---|---|---|---|
| Degrees of freedom | 6 | Statues | 7 | 2.83 |
| Significance level | 0.001 | | | |

**Table 15: Rating indexes of users'diversity**

| | | Factors | Rank | Average Rating |
|---|---|---|---|---|
| **Sample size** | **167** | Presence of youth | 1 | 3.52 |
| | | The presence of women | 2 | 3.18 |
| | | The presence of children | 3 | 3.17 |
| Chi | 88.528 | The presence of men | 4 | 2.82 |
| Degrees of freedom | 4 | Presence of the elderly | 5 | 2.31 |
| Significance level | 0.001 | | | |

**Table 16: Rating indexes of diverse behavioral settings**

| | | Factors | Rank | Average Rating |
|---|---|---|---|---|
| Sample size | 167 | Availability of spacesfor collective activities such as walking | 1 | 3.54 |
| | | Availability of places to sit | 2 | 3.18 |
| | | Availability of spaces for meeting and conversation | 3 | 2.87 |
| Chi-square | 59.362 | Availability of spaces for collective activities such as watching movies | 4 | 2.82 |
| Degrees of freedom | 4 | Availability of spaces for the residents'gathering | 5 | 2.59 |
| Significance level | 0.001 | | | |

**Table 17: Ranking of indexes of diversity of materials, colors and forms**

| | Factors | Rank | Average Rating |
|---|---|---|---|
| Sample size: 167 | Using different colors | 1 | 5.12 |
| | The use of materials such as stone and brick | 2 | 3.78 |

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| | | | | |
|---|---|---|---|---|
| | | The use of stone materials | 3 | 3.65 |
| | | The use of brick materials | 4 | 3.21 |
| Chi-square | 287.122 | Using two colors | 5 | 3.19 |
| Degrees of freedom | 5 | Using a single color | 6 | 2.04 |
| Significance level | 0.001 | | | |

**Table 18: Rating the visual and physical permeabilityindexes**

| | | Factors | Rank | Average Rating |
|---|---|---|---|---|
| | | Creating green spaces in the entrance of complexes | 1 | 6.65 |
| | | Easy access to outdoor | 2 | 6.03 |
| **Sample size:** | **167** | Presence of spaces between public and private spaces | 3 | 5.08 |
| | | Transparent walls | 4 | 5.02 |
| | | The low number of floors | 5 | 4.24 |
| | | Retreat ofthe entrance of complexes | 6 | 4.05 |
| Chi | 534.958 | The lack of wall and fence | 7 | 2.64 |
| Degrees of freedom | 7 | Flat and tall walls | 8 | 2.30 |
| Significance level | 0.001 | | | |

**Table19: Stepwise regression analysis for the influence of architecture on vitality and happiness of residents**

| Steps | Predictor variables | F | Beta | Correlationcoefficient (R) | The regression coefficient (R²) | The significance level |
|---|---|---|---|---|---|---|
| First | Diversity of users | 76.30 | 0.562 | 0.562 | 0.316 | 0.001 |
| Second | Diversity of users Mixed land use | 48.95 | 0.482 0.253 | 0.611 | 0.374 | 0.001 0.001 |
| Third | Diversity of users Mixed land use Materials, color and form | 37.04 | 0.409 0.243 0.194 | 0.637 | 0.405 | 0.001 0.001 0.004 |

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| Analyzing effect of not forecasting green space on the vitality and happiness of the residential complex of AtisazShahindezh | |
|---|---|
|  | Trees are arranged randomly and tree plays just the role of green spaces, which has caused creation of a dense forest in in the yard (see Figure 1) |
|  | The shading role of trees in forgotten in the main meeting spaces and as can be seen in Figure 2, the sitting area lacks shading trees. |
|  | The greenness can be seen in the yard, but it had not penetrated the residential units. Despite the wide terrace in each unit, green space in the terrace is nothing more than a few pots and its greenness is not visible in the facade |

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| | |
|---|---|
|  | The main path of water is located in a far and isolated location and this has caused the lack of using of its potential so that it has norole in the vitality of the residents. |

**Fig. 1: The reasons for the lack of foresight for green space in vitality changes in Atisaz Complex (Source of table and Photo: author)**

| The analysis of not forecasting the physical and visual permeability in changes of vitality and happiness of AtisazShahindezhComplex | |
|---|---|
|  | The bulk arrangement of trees has reduces visual permeability of the building. In addition, the project site is too steep so that regardingthe bulk arrangement of trees, physical and visual permeability is almost destroyed |
|  | The absence of inviting factors in entrance and irrelevance shape of it to the residency issue as is shown in Figure 3 |

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| | |
|---|---|
|  | Presence of high walls in the relatively green yard and entrance is not enough so that this greenness at the entrance, which has the highest frequency in physical and visual permeability from the viewpoint of residents, could be more than only a few pots. Both of which are shown in Figure 4. |

**Fig.2: The reasons for not predicting the visual and physical permeability in vitality changes of Atisaz Complex**

| Analyzing effect of not forecasting the diversity of behavioral settings in variations of vitality and happiness in AtisazShahindezh complex | |
|---|---|
|  | Site'sarea has diverse behavioral settings, but the relationship between these facilitieswith each other is not suitable. For example, the sit and conversation space are far from child's play space and thus away from control of parents. In addition, placement of the dock next to the children's playground in terms of security is false and all these have contributed to the lack of prosperity and vitality of the playground. |
|  | The library was placed in a locationout of sight so that during interviews with residents, they were unaware of the existence of such a space.Overall,the residential complex had diversity of behavioral settings, but the location of these buildingsis not appropriate. |

**Fig.3: The reasons of not forecasting the diversity of behavioral settings in vitality variations of Atisaz Shahindezh Complex(Source of table and Photo: author)**

**RESEARCH ARTICLE**

# Risk Analysis, Cost Estimation and Risk Response Strategies in Wheat Business

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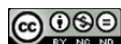
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**ABSTRACT**

The aim of this paper is to study, analyze and predict the probability of success of newly-established firms in wheat industry and its relation with factors such as inflation, costs of equipment's replacement, and business risks that cause losses in wheat sell and buy. The statistical population of this study includes all firms in this industry in Iran. We simulated all the required information, including the annual inflation rate and the yearly cost of substitute equipment, along with the investment risks and factors using Monte Carlo method by @Risk software on 2003 Excel. Based on simulation results, inflation, and the reliability in the business environment have a direct impact on the probability of success of a firm. In other words, the higher the reliability in the business environment or the lower inflation rate, the higher the probability of success. The results testifies the field observations.

**Key words**: Risk management, Monte Carlo simulation, the net present value, cash flow.

## INTRODUCTION

Risk management in business throughout the recent years has been significantly concerned. These days, managers believe that the procedure of identifying, analyzing and assessing the possible risks of business together with the development plans brings major advantages [1]. One of the broadly-usedtechniques of risk analysis is the Monte Carlo simulation. In this simulation method, input value is a random sample of the probability distribution function corresponding to each variable. The model is simulated for many times by repeating the sampling procedure and a

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probability distribution for the whole system can be obtained. The standard approach to risk management includessixrisk management planning processes such as, risk identification, risk qualification, risk quantification, risk response planning, monitoring and controlling [2]. Monte Carlo simulation is often used in the phase of risk quantification. The outcome of Monte Carlo simulation assistssenior managers to make the best decisions in this hectic business conditions.

Significant improvements have been so far achieved with Monte Carlo method empowering this technique to include the business complexities in its analysis and thereby increase the validity of its output results.

Companies in this industry in Iran are often faced with the challenges of survival and income insufficiency. The managers of these firms are often struggling toachieve the benefit. Moreover, awareness of the risks and their appropriate response methods is critical for business managers. Hence, their exists necessity to develop an advanced model to provide appropriate analysis for responding to the needs of managers. Finally, entrepreneurs entering the job market may use this model.

Monte Carlo risk analysis in businesshas been used as a additional tool for manager's decision making. In this method, the major risks such as customer relationship, capital and the inflation rate have been modeled by the Monte Carlo method on @Risk software.

This paper is structured as follows. We first review the Monte Carlo simulation method and the net present value. In the next section,we explain risk analysis using Monte Carlo. The subsequent section expresses the mathematical model, following by a practical example. Then the strategies whichfirmsmay apply in different situations are discussed. Finally, we conclude the paper with recommendations for future research.

## METHODOLOGY

### Review of Monte Carlo simulation method

The Monte Carlo simulation methods applyprobability and statistics techniques. These methods have been usedinvarious sciences, such as nuclear physics, genetics and economics. Nowadays, the use of numerous simulation methods has become popular in many research fields. Knowing these efficient tools and identifying its strengths and weaknesses provide new features for researchers, academic professors, alumni and economists. Amongst the different simulation methods, Monte Carlo technique is one of the mostappropriatetechniques for research and financial and economic calculations [3].

Recent studies reveal that the newly-established companies buying and selling goodsare bankruptafter some time due to the prevailing conditions in the industry in Iran. Themain reason can be mentioned asthe failure to receive the money from their clientsdue to excessive clients' trust. Many managers of these firms, consider the subject of the sales as static form and often conclude withsubjective modelsin order to overcome the complexity. For example, whether it is possible to work with the clients as before with rising inflation, and accept the delivery of the goods with personal checks or promissory notes? Or, considering inflation, with how many percent of the last year's liquidity we can work? Does depreciation of machinery can have an impact on the business? Risk analysis with Monte Carlo method should be seen as a complementary tool for traditional management methods. Traditional tools itself is not effective to deal with complexity. Researches and common applications of Monte Carlo methods are: (1) determine the domain of events, (2) events are specified randomly,(3) due to recent events, domain situation becomes clear [4].

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**Net preset Value Method**

Economic engineering is one of the usualtechniques for evaluating the economic projects. In this method, cash flows (revenues and expenses) based onevent time (income or expense) have been discounted to the current market rates [5]. Net present value is extensively used in the economic calculations, economics engineering, country budget, microeconomics and macroeconomics, trade and industry [6]. NPV is also useful in measuring the technical and economic feasibility of projects [7]. Monte Carlo simulation includes using probability distributions and random numbers to estimate a probability distribution for the NPV index [8]. The classic NPV formula is as follows [9]:

Duration of the cost or revenue
t: time of cost or revenue
i: annual interest rate
$R_t$: net annual income

$$\frac{R_t}{(1+i)^t}$$

**Description of the Monte Carlo risk analysis model**

Based on this case study, the major risks that make companies bankrupt are as the following:

**Inflation:** A sustained increase in the general level of prices for goods and services. It is measured as an annual percentage increase.

**The cost of machinery substitution:** One of the factors may incur high costscan be mentioned as replacing new machinery with old and spoiled ones, this replacement includeschanging cargo vehicles or parts that are in stock.

**The factors of market's ability for investment:** One of the most important factors in the business market is how many percent of last years capital will be spend for the current year. Studies show that if in the previous year, the profit will be negative, therefore there will not be any investment for the current year, however, if the amount of profit in the previous year is lower that the bank interest rate and higher that zero, then investment for the current year is between 0.4 to 0.8, and if the profit in the previous year is higher than the bank interest rate, therefore, the investment rate is between 0.75 to 0.85% of the capital in the current year.

**Factors of customer trust:** another factor for the business is the amount of trust that can be gainedby the customer. This trust depends on many factors, such as customer's credit rating, the greater is this rate, the more is the amount of corresponding transactions. Also, the reliability degree of customer can be between 0 and 1.

Figure (1) shows algorithm determining the probability of success or failure of the company. This algorithm offers a real-world calculation of the net present value. It predicts the impacts of risk factors more accurately with considering the dynamic situations in the business world, and provides a valid basis for analyzing Monte Carlo method. Extensive studies were conducted on previous models in the literature to develop the model. In this model, if the profit of the previous year is zero or below zero, there will not be any investment for the current year.

It is noted that the present model is developed by gathering information frominventory costs, company's office, machinery and equipment, and the information costs of banks. In this research,it is assumed that the

profitforaccepting long term personal checks from customers is fluctuating between 10 and 18 percent, and the sales profit is varying between 5 and 9 percent. The purpose of this model is to perform all necessary operations for the business simulation in the way that how much is the probability of the company's success in the future and what are the responding strategies regarding the inflation rate?

**Mathematical model and formulation**

In this section, we define the parameters of the model and present a mathematical formulation as follows.

$S$ : total Initial costs

$Q$ : cash Flow

$i$ : funds raise rate in a year

$y$ : replacement year of machinery

$N$ : number of the years

$\sum X$ : total incomes

$\sum Y$ : total expenses

$C_{fin}$ : financial expenses, the amounts of money that company has received from other sources such as loans and pays the money back with its interest.

$WUP_0$ : wheat price per kilo

$g$ : annual inflation

$PRV$ : annual depreciation expense

$AVE$ : the cost of equipment replacement

$NPV$ : net present value

$R_r^j$ : the cost of market ability for investment

$T_F$ : seller expectation against customer

$I_K$ : market reliability factor

$c_{system}$ : the cost of purchasing tools and initial equipment

$c_{sub}$ : subsides of purchasing tools and initial equipment

The market ability factor for investment is calculated by equation (1):

$$R_r^j = \begin{cases} 0 & Q_{j-1} < 0 \\ Rand(0.75,0.85) & \text{if } Q_{j-1} \times \text{interest rate} < Q_j \\ Rand(0.4,0.8) & \text{if } Q_{j-1} \times \text{interest rate} \geq Q_j \end{cases} \quad (1)$$

Customer reliability factor iscomputed as follows:

$$I_K = \begin{cases} 1 & Rand_K > T_F \\ 0 & O.W \end{cases} \quad (2)$$

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Market cash flow is determined by the following equation:

$$Q_j = \begin{cases} \left(\sum X_i - \sum Y_j\right) - C_{fin} & j-0 \\ \left(R_r^j * \sum_k I_k \frac{\epsilon_{j-1}^K}{WUP_o \times (1+g)^y}\right) - C_{fm} & j, Q_{j-1} > 0 \\ 0 & Q_{j-1} \leq 0 \end{cases} \qquad (3)$$

Machinery replacement costs is obtainedby equation (4):

$$PRV = \sum_y \frac{(AVE + (AVE.g.y)}{(1+i)^y} \qquad (4)$$

Initial costs of the companies is calculated by the following equation:

$$S = C_{system} - C_{sub} \qquad (5)$$

Earned value is calculated as follows:

$$NPV - -s - PRV + \sum_{j=1}^n \frac{Q_j}{(1+i)^j} \quad (6)$$

# RESULTS

**Practical Example and data analysis**

In this section, we present a real-world case study to analyze the proposed algorithm.Based on the information obtained from the companies in Wheat industry in Iran, the minimum amount of investment in this business is 300'000'000Rials, the average is 500'000'000Rials, and the maximum is 2'000'000'000 Rials. Inflation rate is set to 10, 20, and 30 percent. Return Of Investment (ROI) rate is set to 20 percent and the amount of fixed costs (Buy a Nissan Pickup) is 200'000'000 Rials. To analyze the data we used @Risk software on Excel 2007 environment. We examine differentscenarios with different varying rates and customer credit ratings as follows.

a)Likelihood of success with risk of more than 0.2 and  inflation rate of 10%.
b) Likelihood of success with risk of more than 0.4 and  inflation rate of 10%.
c) Likelihood of success with risk of more than 0.6 and inflation rate of 10%
Table (1) shows the likelihood of success in the wheat market with different scenarios.

# DISCUSSION

Companies develop risk response strategies. The practical realities facing companies today make risk response strategies necessary. Clearly defined and articulated risk response strategies help to ensure that managers take ownership of risk responses and are finally responsible and accountable for risk decisions—understanding, acknowledging, and explicitly accepting the resulting mission/business risk. here are five basic types of responses to risk: accept, avoid, mitigate, share and transfer.While each type of response can have an associated strategy, there

should be an overall strategy for selecting from the basic response types [10]. Companies in wheat industry avoid risk with decreasing the reliability to their customers when the inflation is high. In other words, the companies remove uncertainty [11].

If inflation is low,the firmsacquire risk mitigation strategy. It means that the companies reduce the amount of risk to make it acceptable bydecreasing the impact or risk probability [12].

## CONCLUSION

In this paper, Monte Carlo simulation method has been used to analyze the net present value.

We showed that the more is the degree of accepting risks in a company with a stable inflation rate, the greater is its success. Also we illustrated while inflation is low, the probability of company success becomegreater. In this study, the ability of risk acceptingis determined by continuous uniform distribution [0,1]. For future studies, we recommend to use impact probability matrix to find risks and the amount of their probabilities. Also, we suggest to apply the equations, models and Monte Carlo simulation technique used in this research tothe other case studies in order to evaluate the business success in different scenarios.

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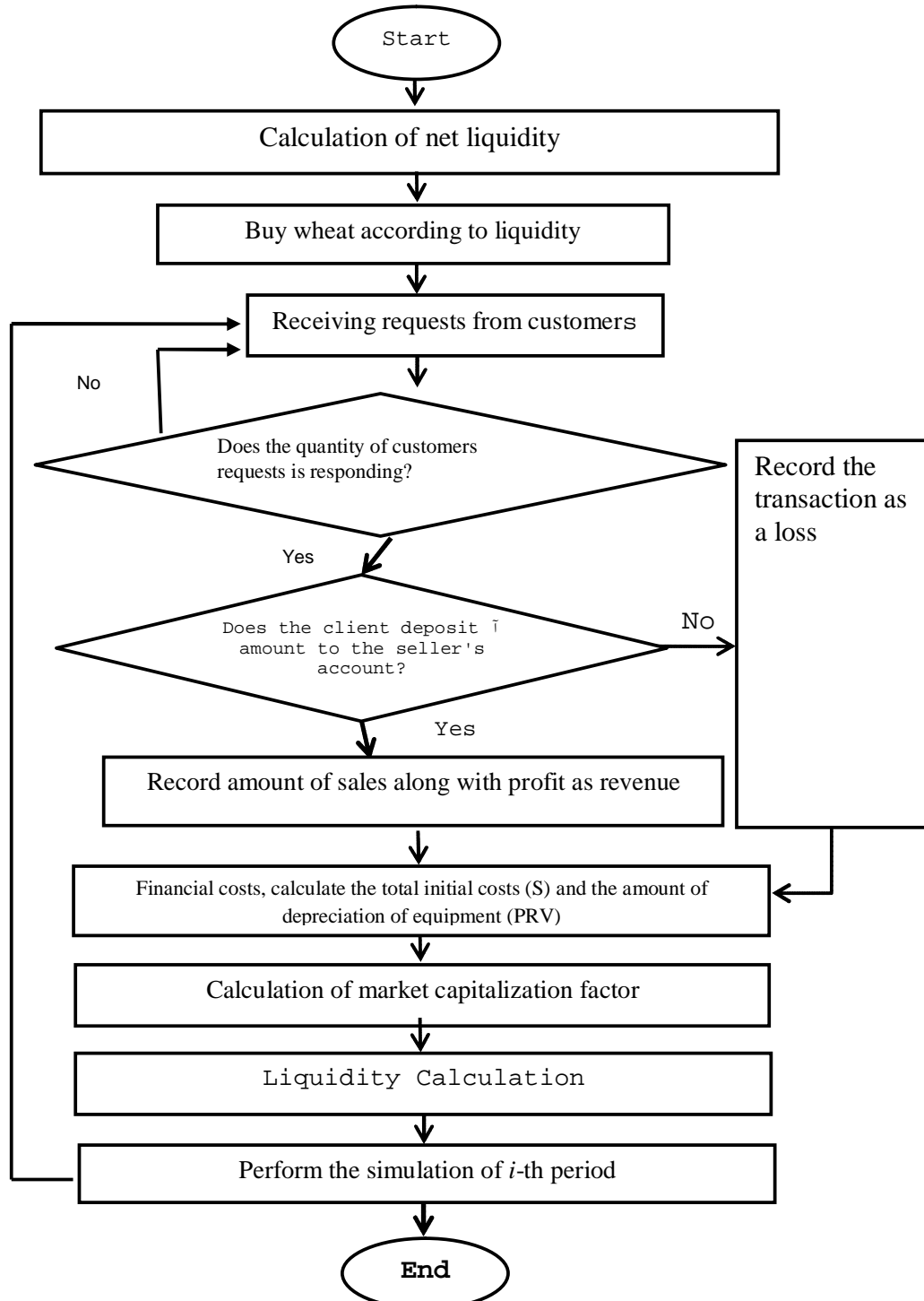
**Mohammad Khalilzadeh**



**Figure 1: Risk analysis computing algorithm with Monte Carlo method**
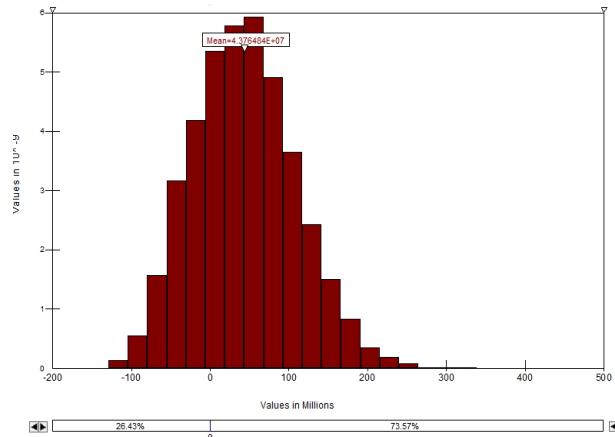
**Mohammad Khalilzadeh**



**Figure 2.Simulation with risk t of more than 0.2 and inflation rate of 10%.**
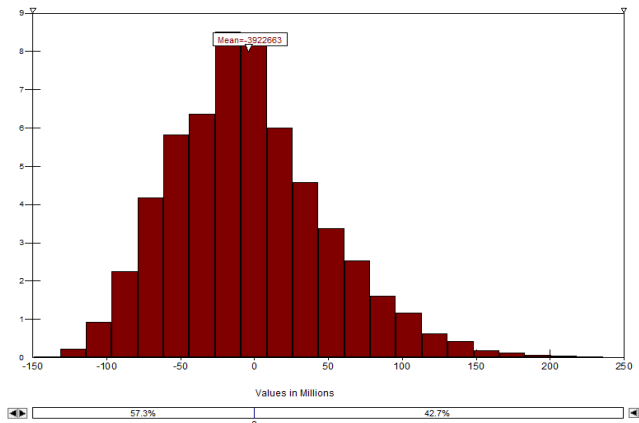


**Figure 3.Simulation with risk taking of more than 0.4 and inflation rate of 10%**
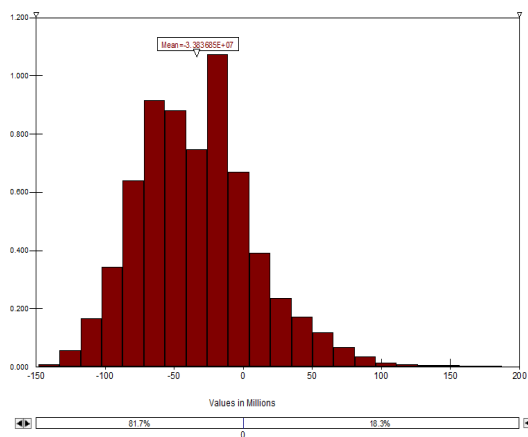


**Figure4.Simulation with risk taking of more than 0.6 and inflation rate of 10%.**

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**Table 1.Likelihood of success in market**

| Customer credit ratings | Inflation rate | | | |
|---|---|---|---|---|
| | **40%** | **30%** | **20%** | **10%** |
| $x > 0.2$ | 69.37 | 70.56 | 71.66 | 73.57 |
| $x > 0.4$ | 35.28 | 37.29 | 39.64 | 42.7 |
| $x > 0.6$ | 12.89 | 13.44 | 14.51 | 18.3 |

**RESEARCH ARTICLE**

# Understanding and Analyzing the Factors Affecting the Vitality of Students in High School Educational Facilities (Case Study: High Schools in Tehran)

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**ABSTRACT**

Education is the foundation for achieving a prosperous society; and factors related to environmental qualities and architecture of educational spaces dramatically affect learning and teaching. Many studies have proven the impact of these factors on student learning. The main issue in this study is the low levels of vitality and happiness of students in high schools as one of the main problems in the country's education system. This study will also identify the factors that increase the sense of vitality in educational facilities, delivering practical solutions to enhance the feeling of vitality and subsequently improve the quality of the educational environment through architectural design. In this regard, the factors affecting the vitality of educational facilities were evaluated in four general factors including structural factors, environmental factors, psychological factors and social factors. For this purpose, effective factors were extracted by literature review, semi-structured interviews with experts and environmental surveys. After content analysis, data were collected for Delphi method validation and also checking the priority of each of the factors of AHP, questionnaires were distributed among the panel of experts. The population of this study consists of professors and experts from the Faculty of Architecture of the National University of Tehran. The sample consists of 8 individuals at the interview stage, 14 at the validation, and 12 professors and professionals at the pairwise comparison stage. Then, the obtained data has been analyzed; and according to the analysis, architectural solutions to improve the overall quality of the teaching spaces were provided. In this study, the software Expert Choice 11 was used to speed up the calculation of the

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factors weighted average. According to research findings, social factors and environmental factors have the greatest impact on the vitality of educational facilities.

**Key words:** Vitality, physical factors, environmental factors, psychological factors, social factors, secondary educational environments

# INTRODUCTION

Education is the foundation for understanding healthy society and its risk factors and unlimited relationships between people and at the same time its totality make the education a more complicated phenomenon than ever. Some of the factors that are relevant to its environmental conditions, among other factors would have a considerable impact. Studies have shown that environmental conditions strongly affect the learning of children and adolescents (Mahmudi, 2005). Educational space is considered as an important factor contributing to the recovery and improves the quality of teaching and learning. Physical space can help improve student learning in the area of cognitive, emotional and enhance his skills and motivation (Bakhtiar nasrabadi, 2006). Low levels of happiness and a sense of vitality, students in high schools is one of the fundamental problems in our country's education system. Reluctance to learn, laziness, sluggish feeling, academic failure, truancy are signs of a lack of happiness and vitality in the Boy's High School. Of course, this problem is not unique to schools but our society is lacking happiness. But due to the fact that high school students during a passionate and energetic life, and it is also almost a third of the hours in a day to spend in the school environment, addressing the issues of vitality and happiness in schools is of particular importance.

Happy and fun learning environment influences the students' talents And will double up their energy. Joy and happiness is dependent on attractive, desirable and refreshing schools. While the majority of students see the physical and social environment of schools as tedious, boring and without mobility, dynamism, joy and sometimes suffocating (Yasin, 2001). Increased anxiety, depression, lack of self-confidence, a sense of hopelessness about the future, being away from school or home, suicide and risk factors of unhealthy competition that are evident in education and the community Reveal the need for research on school personnel (Ja'fari et al., 2008).

### Background check

Many researchers have reported that vitality as a concept that is difficult to define and measure. Vitality is an umbrella term that encompasses a variety of meanings, which are subjects that are measured, depends on the perspective of those who do these measurements. Halen (2006) showed that there is no consensus in the literature related to the dimensions and characteristics that are necessary to understand this concept. This difference in views is normal because they have different intellectual fields. So vitality has been used in several studies; including various aspects of individual, community and country to various fields such as ecology, geography, sociology and urban planning (Lau Leby and Hariza Hashim, 2010).

Vitality is a concept that offers a picture full of life and living conditions in a place that is so desirable to improve quality of life. In general vitality is directly related to the quality of life and well-being experienced by the inhabitants of a particular region. In a residential environment, vitality mainly refers to the physical environment that surrounds the person as soon as they come out of the house and walking or driving in the streets of the neighborhood to access the bus station or the main street. This determines the perceived image of a place, vitality and desire to live in a specific location (Gerrardbown, 2006). According to Brooke Lyndharst The interpretation of vitality varies according to time and place, but it seems this is a common sense phrases such as quality of life, wellbeing and life satisfaction. In the United States, vitality generally refers to the "quality of life" and "health". While in England "vitality" refers

only to the local environment, the cleanliness, security and green spaces Brook Lyndhurst, 2004); quotes (Pandey et al., 2010). Vitality refers to the environment from the perspective of the individual, as well as a subjective assessment of the quality of housing conditions (Heylen, 2006). In a simpler form vitality includes the features of the urban environment that make the places attractive to live. Such features can be divided into tangible property, particularly with respect to the availability of public infrastructure; And intangible characteristics such as sense of place, local identity and social networks (Throsby, 2005). Throsby in the context of urban renewal emphasizes the role of cultural capital in improving the urban environment.

Balsas studies on the reconstruction of the city center, a center of vitality has come to mean the ability to maintain and improve its livability (the capacity to absorb continuous investment) and vibrancy and vitality (to survive). He confirmed that the five factors Lynch (1998) to form the town (vitality, sense, fit, access and control), and adds the viability to the list; He argues that a city without it may not be livable place. He further elaborated that a livable place should be: safe, clean, beautiful, economically dynamic, cost-effective, managed effectively, the appropriate infrastructure applications, including interesting cultural activities, has numerous parks, establish effective public transport, supporting a broad career opportunities and providing a sense of community (Balsas, 2004). All these factors are along with Wheeler definition of vitality, as the quality of the enjoyable, security, affordable and supportive of human society (Wheeler, 2001).

In general selection criteria depending on the researchers' discipline, culture and goals will be different. Omuta uses five main factors in studies to measure the subjective quality of life, in determining the vitality neighborhoods in the city of Benin in 1988; Employment, housing, adaptability, education and socio-economic factors. Most of these are used as secondary issues related to the quality of the environment. For example, in the study of Holt-Jensen (2001), some of which have appeared to improve a deprived neighborhood. The factors that are considered important by residents for a good location include aesthetics, performance, social relationships and individual factors. Halen (2006) draws our attention to the four criteria of vitality that is often observed in Flander and the Netherlands; The quality of housing, the quality of the physical environment, social environment quality and security of the neighborhood. Some criteria were used by Visser (2005) in order to show their impact on the economy of residential neighborhoods in the Netherlands. These features are divided into four groups: Physical features of the house, Physical properties of the residential environment, Social features and characteristics of the residential environmental, and performance of the residential environment. In another study which is a report of vitality in the UK, the researchers express four key indicators for the vitality: These characteristics include environmental quality, the quality of physical location, quality of functional places and more secure places (Lau Leby and Hariza Hashim, 2010). Jackson explained the effects of green space on humans in both mental and physical level. Visual and physical access to green space plays an important role in the welfare of the community (Jackson, 2003). Insufficient green space in residential neighborhoods reduces the opportunity for residents to experience nature out of the indoor spaces, which may reduce physical activity, behavioral problems and social isolation (Lindheim & Syme, 1983). As Emmanuel said, the geometry of built form and density is one of the variables that affect thermal comfort in outdoor (Emmaneul, 2005). According to Ancelotti studies the exterior spaces that provide thermal comfort conditions characterized by a high level of vitality. This is one of the better thermal comfort conditions may cause an increase in human productivity (Angelotti, 2007).

The road network also plays an important role in creating a built environment for social interaction. Paths, intersections and sidewalks defined, are effective in encouraging residents to walk. Comfort provided by the strategic location of public facilities and services to meet the daily needs of residents, reduce the use of vehicles in residential areas. Comfortable Sidewalks in a residential neighborhood not only reduce pollution from vehicles, but also through frequent visits to the neighbors in the street, strengthen local networks and social sense, which are important for mental health (Barton et al., 2003).

William Sullivan and colleagues at the research on lively neighborhoods have emphasized the existence of trees and grass as one of the key components in the vibrant neighborhood spaces. They showed that the presence of trees and

grass has a direct connection with the 'use of open spaces and the social activities that take place in them (Sullivan et al., 2004).

**Research Questions**

This research seeks to increase vitality in education in the high schools. The main question of this research is to create or enhance a sense of vitality architectural solutions among male high school students of Tehran. In this regard, the following questions are raised:

**The main questions**

What are the characteristics of secondary educational environments involved in vitality?

What is the importance of each of the affecting factors on the vitality of secondary education in relation to other factors?

**Minor points**

Can the presence of natural elements in a learning environment promote vitality?
Can the learning environment capability to encourage students to collective actions and social interactions lead to vitality improvement?
Is the sense of security effective in creating vitality in the learning environment?

# METHODOLOGY

The nature of this research is qualitative, because it is looking for the qualities that make the schools vital. However, due to quantify qualitative factors, a combination of qualitative and quantitative strategies is used. The independent variable is the environmental qualities of educational facilities; and the vitality of learning environment is the dependent variable.

**Research stages**

First: review of the literature

Second: semi-structured interviews with professors and professionals

Third: analysis of content derived from a literature review and interviews, and set the target table of content

Fourth: development of validated questionnaires of the target table of content and its distribution among professors and professionals

Fifth: assessment of validated questionnaire  and developing a questionnaire of paired comparison matrix of factors to calculate the significance the variables according to the results of the fourth step and distributing it among professors and specialists

Sixth: Analysis of the questionnaire paired comparison matrix of factors and conclusions.

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In this research to validate factors (step four), Delphi method is used. And to determine the impact of these factors on the vitality and compare them with each other (step five) AHP method was used. The population of this study consists of professors and experts from the Faculty of Architecture of the National University of Tehran. The sample includes 8 individuals at the interview stage, 14 at the validation, and 12 professors and professionals at the pairwise comparison stage. Network method (snow pellet or chain) was used for sampling.

Ludwig pointed out that the number of specialists in the Delphi method is generally determined by the number of people required to form a consensus and judgment and the ability to process information in the team (Ludwig, 1994). However in the optimal number of experts in a Delphi studythere is no consensus in the literature (Hsu & Sandford, 2007). Delbecq, Van de Ven, and Gustafson suggest that a sample size of 10 to 15 people to study the Delphi method may be sufficient, as long as the homogeneity of professional background (Delbecq et al., 1975). witkin and Altschuld point out that the panel of experts in the Delphi method is generally below 50, but they can be used more (witkin & Altschuld, 1995). AHP is also one of the most versatile techniques of decision-making, which was developed in the 1970s, first by L.saaty. This method of operation can be used when making a decision criterion is faced with several competing options. The proposed measures can be quantitative and qualitative. The basis of the decision making method is based on pairwise comparisons. Decision maker by providing a decision tree hierarchy, begins the process. Decision tree hierarchy shows that factors compared and evaluated the competing options, Then comes a series of pairwise comparisons. This comparison determines the weight of each factor in line with the rival options. Finally, the logic of pairwise comparisons matrices AHP to be combined together make the optimal decision is achieved (Azar and Memariani, 1994). The Expert Choice 11 software is used to speed up the calculation of the weighted average factor.

## RESULTS AND DISCUSSION

The graph below shows the relative weight of the different factors affecting the schools vitality. The greatest impact is for the social factors with the relative weight of 0.321. And then, with slight differences, environmental factors with the relative weight of 0.309 are in the second rank. Physical factors and psychological factors with the relative weight of 0.200 and 0.170 are in the third and fourth ranks, respectively.

Among the components of the physical factors, the greatest impact on vitality of schools is related to these components: Spatial diversity with relative weight of 0.212 and then flexibility with weight of 0.200, scale with 0.171, combination of mass and space with 0/149; form with 0.141, and readability with 0.126 are in next ranks, respectively.

Among the components of environmental factors, the greatest impact on vitality of schools is for the component of natural elements with an average weight of 0.240. And then with an average weight of 0.234 we have environmental comfort. After that, with an average weight of 0.232 the natural light is in the third place. The Audio component with 0.174 and the color components with 0.120 have been placed in the next rankings.

Among the components of the psychological factors, the sense of security with the relative weight of 0.240 has the greatest impact on the vitality of schools. Cleanliness and hygiene with the relative weight of 0.327, and visibility with 0/180 are in the second and third places.

Among the components of social factors, the component of collective action platform with the relative weight of 0.240 has the highest impact on the vitality of schools. Freedom of action in the environment with relative weight of 0.354, and scale population with the relative weight of 0.220 is in the second and third places.

## CONCLUSION

According to the study, the greatest impact in promoting a sense of vitality in secondary schools related to social factors. So, learning spaces should be designed to provide a good platform for collaborative activities. In a way that allows for increased social interaction and group activities, either in class room when teaching, and the outdoors in leisure time.

Other important factors in the vitality of schools are environmental factors. Landscape design should increase the students' relationship with natural elements such as trees, water and etc. It is also appropriate to adjust the environmental comfort conditions in outdoor spaces provide the possibility of classes in exterior environments. The presence of natural light in the school environment also increases the feeling of vitality. In the design of schools, considering the space with natural light not just for classes, but also is essential for the corridors, rooms and any other space that learning and interaction with people can happen. Painted surfaces, paint, furniture, and even the color of uniforms also affect the vitality of educational facilities.

Among the physical factors, spatial diversity and diverse perspectives are important. Also a flexible learning environment influences the vitality of schools. Therefore, these cases should be considered in designing the schools: connectivity and proper separation of spaces devoted to office space for multiple activities and different place, perfect infrastructure and moving furniture. Among the psychological factors, components "sense of security" has the greatest impact on the vitality. To promote a sense of security, the schools should be designed to allow natural surveillance, and also observes the Rules of defensible spaces, traffic safety and access control.

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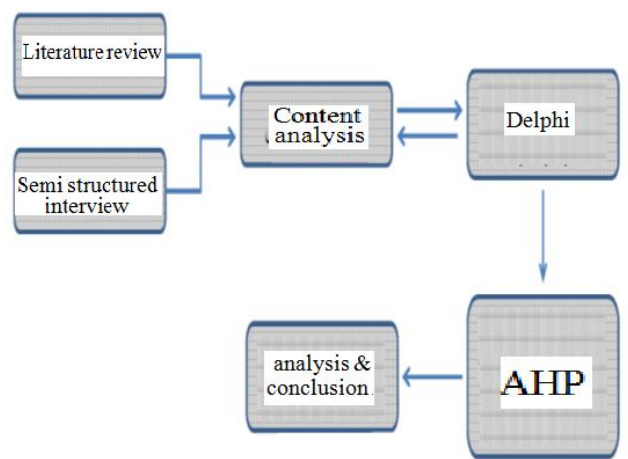
**Figure 1 - Stages of research**

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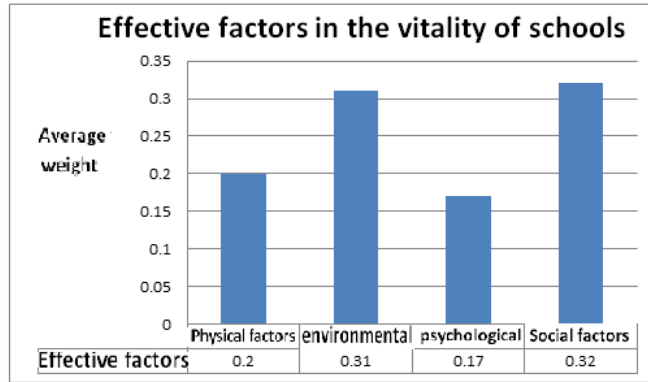


**Figure 2 - The relative weight of the factors affecting the vitality**
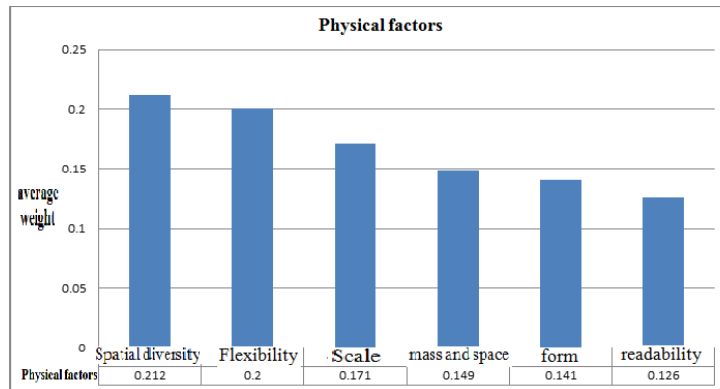


**Figure 3 - Comparison of physical factors**
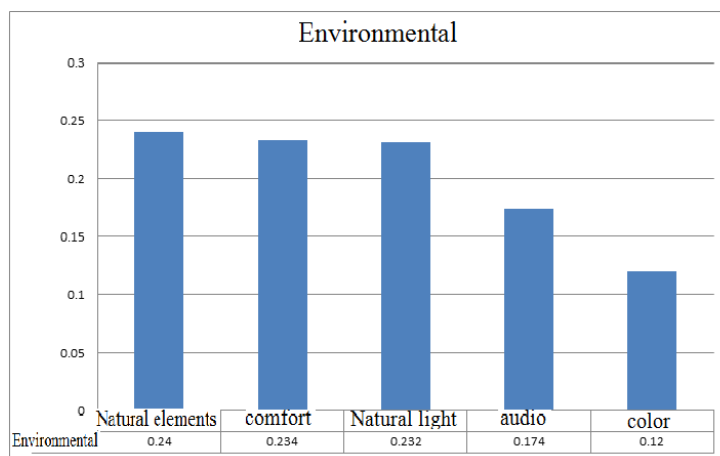


**Figure 4 - Comparison of environmental factors**

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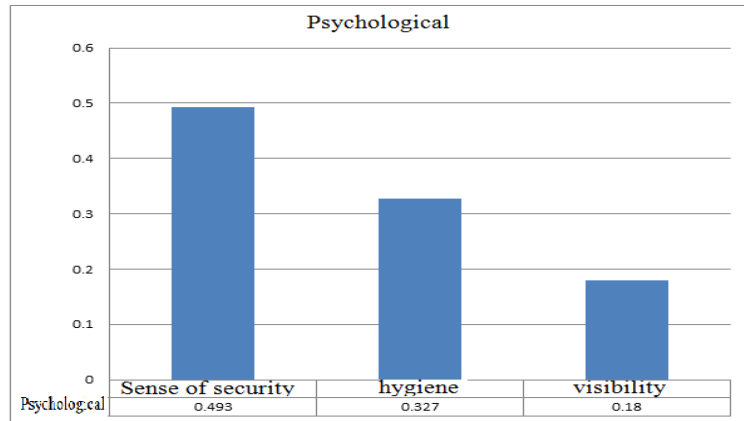


**Figure 5 - Comparison of the psychological factors**
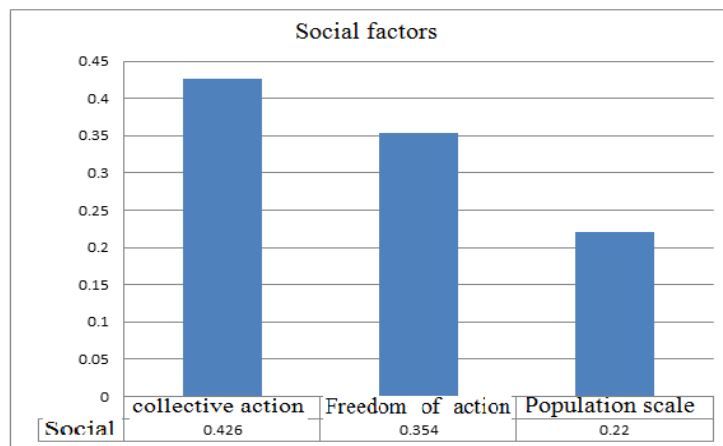


**Figure 6 - Comparison of social factors**

**Table 1 - Average weighted factors affecting the the vitality secondary educational spaces**

| 0.426 | collective action platform | 0.32 | Social factors |
|---|---|---|---|
| 0.354 | Freedom of action in the environment | | |
| 0.220 | Population scale | | |
| ∑ = 1 | | | |
| 0.240 | Natural elements | | |
| 0.234 | Environmental | | |

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| | | | |
|---|---|---|---|
| | comfort | 0.31 | Environmental factors |
| 0.232 | Natural light | | |
| 0.174 | audio | | |
| 0.120 | color | | |
| ∑ = 1 | | | |
| 0.212 | Spatial diversity | 0.20 | Physical factors |
| 0.200 | flexibility | | |
| 0.171 | scale | | |
| 0.149 | Combination of mass and space | | |
| 0.141 | form | | |
| 0.126 | readability | | |
| ∑ = 1 | | | |
| 0.493 | Sense of security | 0.17 | Psychological factors |
| 0.327 | Cleanliness and hygiene | | |
| 0.180 | visibility | | |
| ∑ = 1 | | | |
| | | ∑ = 1 | |

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**SPECIAL ARTICLE**

# Towards a State of Ecological Integrity: Eco-Philosophy, Sanctity of Life and Ecological Renaissance: Imperatives of Our Contemporary World

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**ABSTRACT**

Great ecosystems are like complex tapestries-a million complicated threads, interwoven, make up the whole picture. Nature can cope up with small rents in the fabric, it can even, after a time, cope with major disasters like floods, fires and earthquakes .What nature can't cope with is the steady undermining of its fabric by the activities of man. Humanity in situation needs to understand its role and responsibility as a dominant force towards the state of ecological sustenance, start accounting for and governing the sanctity of life, and actively foster societal development in tune with the planet of which we are part. It is time to reconnect to the ecosystem.The need of the hour is to help the universe and all its creatures in the journey of self-actualization and in the process of healing the earth, making it blossom again and paint renaissance enmeshed with the imperatives of our contemporary world.

**Key words:** Eco-Philosophy, Ecological, Ecosystem.

## INTRODUCTION

**The biggest irony**

Man has been endowed with reasons, with the power to create, so that he can add to what he has been given. But upto now he has not been a creator, only a destroyer.'-Anton Chekhov

## Deeksha Rajvanshi

Only after the last tree has been cut down, only after the last river has been poisoned, only after the last fish has been caught, will you realise that money cannot be eaten????Nature is showing some irreversible signs of vulnerability. It is time to stand together and stop unravelling the web of nature.

**Seed of ecological integrity**

"Integrity" is "the state of being unimpaired, sound," "the quality or condition of being whole or complete." Therefore, a system subject to external disturbance will retain its integrity if it preserves all its components as well as the functional relationships among the components. Ecological integrity is the abundance and diversity of organisms at all levels, and the ecological patterns, processes, and structural attributes responsible for that biological diversity and for ecosystem resilience.

**Beautiful concept of interdependence shown by nature**

The large trees of forests provide shade to fish-bearing streams that would otherwise heat up, causing the fish in them to die.When streamside trees are cut down, large amounts of fine sediment reaches the stream, affecting water quality and fish habitat. Large predators, such as bald eagles, help to control the population of small rodents that otherwise would increase and thus have negative consequences for the forest.

Thus when this chain, ecological integrity is compromised, ecosystems can no longer supply goods and services, which affect the economic survival of communities that rely on them and many plants and animals become locally extinct.

**Eco-Philosphy**

It sees humanity as one with nature, as an integral part of the process of evolution which carries the universe onward from inanimate matter to life, to consciousness, and ultimately to divine. The crux of eco-philosophy is "The World as Sanctuary."

**Five tenets of eco-philosophy are as follows**

1. The world is a sanctuary.

2. Reverence for life is our guiding value.

3. Frugality is a precondition for inner happiness.

4. Spirituality and rationality do not exclude each other, but complement each other.

5. In order to heal the planet, we must heal ourselves.

Techniques are the tactics for living.  A holistic approach towards nature is desired. We are the eyes through which universe looks at itself.

## Deeksha Rajvanshi

**New vision for man: co-creative partner of evolusion**

To see the world not as a place for pillage and plunder, an arena for gladiators, but as a sanctuary in which we temporarily dwell, and of which we must take the utmost care.To see man not as an acquisitor, but as a guardian and steward.To see knowledge not as an instrument for the domination of nature, but ultimately as techniques for the refinement of the soul.It is thus time to abandon our exploitative attitude toward nature in favour of an ecological perspective and a new form of spirituality.

**Sanctity of life: being hoodwinked?**

It is ironic that now, at a time where advances in technology and knowledge have given us an increased capacity to preserve and prolong life, we find ourselves increasingly asking questions about the value of the lives we are saving. The triumph of industrialisation is engulfing and disrupting nature. Here are some alarming irreparable signs which are violating this basic concept of 'SANCTITY'.

Tar and oil are washing up on beaches, fish and wildlife stocks have plummeted, some are just gone.Mississippi recently opened their season, and their oyster fishermen are restricted to 12 sacks of oysters a day. But they can't even reach six.Ten percent of the world's reefs have been completely destroyed.

Introduction of exotic Species wreck havoc. In the Great Lakes Basin, the accidental introduction of two small pelagic fishes, the alewife and the rainbow smelt, combined with the simultaneous overharvesting of natural predators, such as the lake trout, led to a significant decline in native fish species.

**About half of the world's tropical forests have been cleared (FAO)**

If these trends continue at the same place, our storehouse of wisdom will turn into a holocaust. We all know-the earth does not belong to man, man belongs to the earth. All things are connected like the blood which unites one family. Whatever befalls the earth befalls the sons of the earth. Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web, he does to himself. Thus, if we do not take action quickly to reverse this trend, then we risk the collapse of the ecosystem that makes our planet habitable.

**Ecological renaissance: a new era**

This new era is a dramatic change from one that perceived people and nature as separate actors to one that sees them as interdependent social-ecological systems. The common notion has divided the world into the natural and social, with humanities as part of the latter. But now it's time to enter the new era that both the dimensions are dynamic and interconnected. It is rightly said that- 'Everything in nature depends on everything else.' It is we who are responsible for our future; we are making our tomorrows. We must make an effort to improve society and the world, for ourselves and for coming generations.

**Main underlying principle of renaissance**

Neo-humanism: Respect for all living beings when human caring expands and embraces all living beings and even the entire inanimate universe, ordinary humanism becomes neo-humanism. Neo-humanism provides a philosophical basis for building a new era of ecological balance, planetary citizenship and cosmic kinship. We have inherited an incredibly beautiful world. It is in our hands whether our children inherit the same world. We must not be the generation responsible for irreversibly damaging the environment.

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## CONCLUSION

Wangari Maathai (winner of Nobel peace prize, 2004) beautifully lays stress on the burgeoning need to save our planet-" I reflect on my childhood experience when I would visit a stream next to our home to fetch water for my mother. I would drink water straight from the stream. Playing among the arrowroot leaves I tried in vain to pick up the strands of frogs' eggs, believing they were beads. But every time I put my little fingers under them they would break. Later, I saw thousands of tadpoles: black, energetic and wriggling through the clear water against the background of the brown earth. This is the world I inherited from my parents.

Today, over 50 years later, the stream has dried up, women walk long distances for water, which is not always clean, and children will never know what they have lost. The challenge is to restore the home of the tadpoles and give back to our children a world of beauty and wonder" Thus the future lies in our hands .Lets do the needful.

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**RESEARCH ARTICLE**

# Review and Recognize the Impilicit Values in Iran Traditional Desert Architecture (Semnan Province)

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**ABSTRACT**

Iran traditional architecture has strong support of various aspects of sustainability, art and Iranian culture and represents special contribution of this culture and art. The review of this feature can be applied in planning and designing and popularity of today living enviornment (Pakzad, 69, 2007).  Nowadays, it is necessary to study and recognize these values and update them due to the residential needs of urban populations and especially traditional cities. Semnan Province has a kind of architecture which involves Iran Central desert features due to its long historical background and common borders with Iran central desert. The province experiences this architecture and its potential values. Therefore, the present study proposes to recognize, renew and restore these values and also reviews the concepts and definitions of traditional architecture and its values using research methodology, historical – interpretation method and library studies. We analyze an indicator sample in the province and how to indicate these values in this straditional House. Ultimately, it is presented the extracted indicators of Tadayon House.

**Key words:** Historical architecture, traditional architecture, vernacular architecture, self architecture, meaningful architecture, local architecture, sustainable architecture, Semnan desert

## INTRODUCTION

The Lack of attention to the foundations of traditional architecture and various effective factors has left a worn and unstable body of architecture texture. Undoubtedly, developing technology is a necessity which can't be neglected. However, this factor shouldn't threat our values especially in architecture and enviornment. Along this, it must be

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identified forgotten strategies in designing traditional architecture and sustainable residential environment and/or used them considering available technology in designing sustainable buildings by updating them (Golkar, 44, 2007).

Iran central part consists of thousands of square kilometers area and its height from sea level is between 500-150 m. Central desert is one of the driest areas and during the summer, it  is the among the hottest areas of the world. However, the remarkable number of Iran big and important cities had been located and developed along the desert (such as Sialk, Kerman, Yazd, Kashan and Semnan and so on) (Mellatparast, Mohammad, p 121, 2009).

Traditional architecture is a term observed in many architects speeches, articles and books and presented discussions in schools. But, in the queries of different people, we find everyone defines this term in his/her own attitude and considers a particular concept for it. So, firstly, we try to think about it and then achieve a clearer sense of traditional architecture.

## METHODOLOGY

The used methodology of this research is historical – interpretation method and field studies have been performed using case samples. Data collecting method is field and documents study in which the gathered data are analyzed. Also, to plan a targeted research structure, written survey questions are as follows:

- To identify the components, elements and lasting and stable principles (tradition) in Iran traditional-desert architecture.
- To identify does traditional architecture involve a single definition and what are the traditional architecture definition and its dominant meanings?
- Is it possible to provide a unit definition of traditional architecture and which meanings can be percieved?
- Is it possible to use desert climate potentials to design modern sustainable architecture?
- How can past valuable architectural concepts and criteria be used to design modern sustainable architecture?

In research process, it is targeted to answer resaerch questions and find out a strategy of research problem. It is followed by field study and historical – interpretation method.

## RESULTS AND DISCUSSION

Traditional architecture synonymous terms: The most important terms in defining the architecture include historical architecture, old architecture, vernacular architecture, identified architecture, self-architecture, meaningful architecture, local architecture.

**Historical architecture**: it has historical aspect and related to history. So, in fact, it related to built architecture of a certain time period. The author wants to state a time load by this term (Pei Nahid, Sadegh, Soffe, No.48, p8).

**Old architecture**: In this type of architecture, time dimension is considered. The term "old" means "ancient, past and former" (Moein Persian Dictionary, p 693).

So, it isn't related to the present time and rooted in the past' it must be respected. The other point about this term is its holiness. The term "Old" is one of Allah name (Pei Nahidm Sadegh, Soffe, No.48, p8).

**Vernacular architecture:** it belongs to special land and district. The term "habitat" has place load and includes a specified range of place which has a defined border (Moein Persian Dictionary, p 220).

The other close words are locality and local which have the same load. It also involves a specified range of place which has special climate and enviornmetal conditions. So, these two synonyms of traditional architecture namely vernacular and local architecture emphasize on defined range of a place and its compatibility with the environment and climate (Pei Nahid, Sadegh, Soffe, No.48, p8).

**Identified architecture**: it is another synonym for traditional architecture. Identity is literally defined as concepts such as essence of God, existence, entity and what would be the identification of the person (Moein Persian Dictionary, p 1014).

Identity means something which can be detected, because there is a history and background about it, has ancestors and prodecessors (Pei Nahid, Sadegh, Soffe, No.48, p8).

**Self architecture**

In discussions about traditionl architecture, the term "self" and "self architecture" is also available. Literally, the term "self" means "familiar." So, self architecture is a kind of architecture which will be familiar, familiar is detectable and all the people understand it. Being familiar happens when there is a history or background of recognition. So, the strangers never will be familiar. Self archtecture is an independent existence and hasn't been imported from abroad.

It is originated from societies own culture and includes social, beliefs, behaviour and peapole customs and traditions and so on. It is fully compatible with these features (Pei Nahid, Sadegh, Soffe, No.48, p9).

Meaningful architecture: in the dictionary the term "" meaning" means intended, purpose, concept, truth, reality, subject and content (Moein Persian Dictionary, p 1014). So, meaningful architecture has an intention. Thereby, it is established not only physical structure but also its intended concept and meaning' not only appearance but also reality is revealed and it flows a fact in it (Pei Nahid, Sadegh, Soffe, No.48, p9).

It is architecture which is originated from not only people desires but also their needs, demands, culture, talents and land requirements and is compatible with its climate and facilities.

So, three main features of traditional architecture are as follow:

Traditional architecture is the product of traditional method in designing and manufacturing and defines as the method of architecture which has been existed in the society and developed over time.Traditional architecture has patterns which reflect society culture; it has been developing and then tranmitting hand by hand over time.Traditional architecture is related to divine issue and is a type of valuable and meaningful architecture.

Due to tradition feature, it can be concluded that traditional architecture is a type of architecture that firstly, has a certain cultural capacity and secondly, it has been developed over time and transmitted hand to hand and generation to generation. This interpretation of traditional architecture has also been provided by Oliver in an article with the same name (Oliver, Paul, 15, P.80).

Traditional values in Iran architecture were often mixed with human and sometimes mystical concepts and used the principles and framework content and specific function as these are known among people and supported by

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production workshops of local materials. This self-sufficiency and relying on cultural, climate and economic products caused to produce wonderful and new spaces of Iran architecture for centuries. Pirnia has developed these principles in which it can be noted to features such democracy, locality, introspection, avoid uselessness and so on (Memarian, Gholamhosein, 1992, p 25).

Tuan believes that only a small part of buildings theat we have and see today would be preserved and maintained into the future; the more distant future is, the less section of the buildings would be lasting. All the buildings that received us hand to hand aren't traditional. But only few of them are of such traditional value. In other words, only the numbers of them which have worthy meanings and values are traditional (Tuan, Yi-Fu).

Now, there is another question: what are worthy meanings and values that a building must have?

To get the architectural and tradtional worthy meanings and values, the article "what is tradition?" which was written by S.H.Nasr is somehow useful. The Arabic word "Aldin" is the most suitable equivalent for the term tradition.

**Shils, in a book about tradition, states that**

Tradition is what has been received hand to hand and generation to generation and includes all the things that a society has in a certain time period. The things which have been available in the society before that period and the current owners have achieved.

According to Shilzs, tradition is not only the product of a physical process in the external world or a series of ecological and physiological requirements but also something beyond it (shils, E, P 12). Traditional society lives in a spiritual system which is seeking full harmony, both qualitatively and quantitatively. Its creatures, such as architecture, originates from perfect worldviews which creates human creative forces, conducts it to an end and at the same time, gives unity to the society as a whole (Ardalan, Traditional concepts of Iran architecture and urban planning, 1970).

Cultural identity of architecture is created by those values which are percieved only in the context of traditional buildings. As architecture is formed to develop values in it and perceives a body for them; otherwise, Iranian traditional architecture was worthless and the architecture of the old buildings was not more than a handful of clay and soil. Iranian art is full of Iranian original genius and the people who create such art, must have an instinct and genius of it. Their art can't be a combination of elements derived from other cultures. This implies that architecture and urbanism has a mission to honor ancient cultural values in it. And accordingly, it is considered as identified element in cultural structure as homogeneity of culture and architecture in the architecture world is seen (Farah, Habib, City Identity, No 3, 2008, p 15).

Iranian-Islamic identity before the the Constitution can be considered as a combination of Iranian and Islamic culture; so, among the components of the (National) Iranian-Islamic identity, it can be noted to national values and norms such as hospitality and chivalry, cultural heritage such as traditional arts, national myths such as Rustam, national symbols such as flag, geographical features such as climate and religion dimension and religious beliefs, including beliefs, rituals and religious ceremonies (Shamshiri, Babak, pp 63-64).

This method is already used in Iranian architecture to build an identified architecture and we call it repeat past patterns method. However, whether this procedure is appropriate to create identified architecture or not isn't discussed in this article. Another style of architecture used in creating identity is to use symbols.

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People in every culture with respect to the past and their history have symbols which create identity for them (Mahdavipour, Hosein, 1998, p058) which can be noted to symbols such as national and religious. Schultz does not consider making and building in occupied space; in the meantime, the most important thing is to reveal spirit of the place and establish a deep connection between earth, texture structure and sky. The nature shape and space, as special relationship between the earth and sky, provides certainty to space and place identity. These characteristics in native architecture comparison can be more seen. Oases density n vernacular architecture and its deep relationship with the land draw a village which meets the human needs and his/her wandering (Christian Norberg-Schultz, 1992, pp 74-52).

It represents the method of using vernacular architecture in the definition of traditional architecture. Also, in the decorative architecture, each role has values which include the value derived from the people opinions in the society. Using these decoratings, the architect emerges community ideas in the building and by the way, it reaches to a type of identity-making in architecture. However, to get the value and identity of Iranian architecture, it can be understood identity- making and valuable elements of traditional architecture by studying Iran traditional buildings principles and getting their dominated wisdom and ideas. According to Dr. Pirnia, features of Iranian architecture include 5 principles including democracy (which includes given proportions and so on and is an expression of psychological factors in architecture), avoid uselessness, Niyarash (recognizing quality and quantity of used material to build an structure), introversion and self-sufficiency which is perceived in all traditional buildings.

Due to the noted content in respect of studying this kind of architecture to use traditional architecture achievements and potential valuable principles of these relics and their appearance, it can be understood these values as below related to dimensions of identity, national and traditional values. Architectural elements of these values in the repeating of past values can be an expression of the national and traditional cultural heritage, the national myth and even the national and traditional symbols. Using symbols can be related to the traditional values, the myths and national symbols and finally religion and religious belief. Designing according to local architect principle is place in geographical features dimension. Decorations make sense related to traditional methods, religious beliefs, myths and traditions and national and traditional symbols. But, these are studied in the five principles of Iranian architecture including democracy (the main school of Islam reflects the fact that Islam does not allow peer worship and staying away from people). On the other hand, architecture attitude to the human is as spirit-oriented and the structure of body is the physical body that the architect makes. The architect is obliged to create the structure of body (in accordance with his/her spirit), avoid uselessness, introversion and self-sufficiency in national values, traditions, geographical characteristics and religious beliefs.

**Semnan tadayon house**

Tadayon or Mohammadie House is of valuable houses of Qajar period in Semnan. It is located in Abbasiye district which is one of five Semnan districts. The building, which belonged to a reputable merchant of Semnan, is adjacent to the north - south of Semnan bazaar and in a sideway alley. Probably, its building was contemporary to the construction of the northern-southern in the Qajar period which includes both exterior and interior with beautiful cellars and a special space of crews and servants, stables and kitchens. It includes three parts: living spaces in the inner courtyard, serving guests and business meetings in the outside courtyard. There is also additional space for service areas related to inner courtyard in southern angles. This house has three entrance doors: the main entrance door of the district common passage (current Taleghani St.), distinct entrance door of outside courtyard of alley which splits up from upper bazaar and is for business meetings and was separated from house residences and another secondary entrance door which has direct access to servant space and stables. Separation of different functions in this house exhibits a perfect sample of Iranian traditional architecture of the old houses. Private living spaces include vestibule, entrance corridor and inner courtyard which indirectly are connected to outer courtyard and the service sector. The components of the inner courtyard include summer living rooms, winter living room, eastern and western terrace (belvedere), pool house, secondary rooms and eastern and western warehouses.Summer

living rooms have high and beautiful wind towers which not only cool down pool house and summer rooms but also provide special beauty to the house view.

In summer and winter living rooms, it has been applied beautiful plaster decorations beside chevron roofs which forms the architectural features of inside courtyard along with particular combination of wind tower in summer living rooms, interior terrace and lower pool house. Exterior courtyard which has primarily been constructed to serve as stranger guests had direct access from the alley which splitted up the bazaar and played the role of office for owner. It includes large rooms on the southern side, corridor connected to the inner courtyard and basement to store the goods in the warehouse. Decorations of the exterior includes beautiful wooden ceilings in the ground floor rooms, chevron roofs and brick ornamentations in the basement.House service sector has also been constructed in the south side of inner courtyard with possible distict access to passage and includes crews and servants accommodation rooms, stables, kitchen, woodshed and so on and is connected to inner courtyard by a corridor.

This building is seen in Mirza Abdollah Shah Qajar photos, Nasir al-Din Shah Photographer, which has been taken in 1867. He has taken these photos during Nasir al-Din Shah trip from Tehran to Mashhad. The restoration of the house has begun in 1994 and after that, it is administered by Semnan Cultural Heritage, Handicrafts and Tourism General Office. This historical relic is located in Taleghani St.

**Exterior**

In the streets of the desert city and similarity of the houses view, the fact which attracts us is the entrance portals (Fig.1). From religious dimension, this is due to the privacy belief and prevents the architect to build even an eyelet to communicate with the outside world. Also, the lack of view decoration reveals the importance of conscience and soul in Islam and indicates that in Muslim living style, there is high emphasis on inner and spiritual dimension in compared to the outer and physical dimensions (Memarian, gholamhosein, knowledge of residential architecture in Iran, introverted typology, Soroush Danesh, Tehran, Spring 2007, p. 316).
From national values perspective, house panel decorations among simple walls around will attract the others and is the symbol of Iranian hospitality. Ultimately, from geographical features aspect, harsh desert winds cause that architects of this regions avoid using eyelet to outside the building.

**House entrance**

The entrance door withdrawal from the passage indicates people religious beliefs not to violate the rights of others (Fig 2). Constructed two platforms on either side of the entrance, in terms of national values and norms, indicates the valuation to communicate with neighbors and attention to civil rights to create rest places on the way and finally, in terms of beliefs, create the right atmosphere to see off and welcome guests and newcomers. The practice of religion is also good as Imam Mohammad Ghazaki has stated that "but, the custom of going out of home is that the guest leaves the house in a proper way and the host should welcome him/her to the house door. It is what Prophet Mohammad (May God peace be upon Him) has said (Soltanzade, Hosein, 1997, p 176)

**Porch or Vestibule**

In designing the place as an entrance pre-space, it has been perceived facilities which can be noted to the lack of direct look as the entrance door is opened in respect of religious dimension (the principle of privacy). But, from the national values and norms (Hospitality and respect to the human perception from the environment), it can be noted to platforms around the porch to create the appropriate space for lighting candles, rest and expecting newcomers. In fact, in this stage, the architects makes the human curious and ready to see a new space by reducing light to passage and increasing the light step by step along the human movement toward the courtyard. The existing decorations of

the short and arched ceiling make the environment height to human height closer (democracy and religious dimension).

**Courtyard**

Tadayon House courtyards have the following features. In general, in Semnan, the buildings are constructed as introverts. It is one of the components of traditional identity. From religious aspect, firstly, introversion (privacy with God and thoughts on creation) is one of the main features of Iranian Muslims. Lower courtyards than passages level to flow the water to reservoirs and small ponds have been provided to use. Tadayon House has two exterior (and interior) courtyards. In exterior yard, by considering national values as well as religious dimension, it has been designed distinct of interiors (by constructing an indirect and seperator corridor between interior and exterior). Exterior courtyard which has primarily been constructed to serve as stranger guests had direct access from the alley which splitted up the bazaar and played the role of office for owner. It includes large rooms on the southern side, corridor connected to the inner courtyard and basement to store the goods in the warehouse. Decorations of the exterior includes beautiful wooden ceilings in the ground floor rooms, chevron roofs and brick ornamentations in the basement.

The traditional architecture of the yard is the central core, geometric space, independent introspective and open up to the sky. The pond and water are elements which intensify such feelings. Fewer places can be imagined in which place and space quality hasn't been increased by water and as Plato states" water is a liquid which makes everything possible: (Toofan, 12: 2003).

There is a pond in the center of yard which emphasizes on water importance and centrality in the universe. The yard represents the center-oriented form of microcosm or soul. The space has been surrounded as potential tressure in the yard as the human soul is surrounded by the physical body. Traditional pond embedded in this relaxed atmosphere provides a center for positive creative imagination. By the way, human lateral creation connects to longitudinal reason and this paradise reconstruction is fulfilled (Ardalan & Bakhtyar, 68: 2001).

**Belvedere**

In Tadayon House, the important components of the interior courtyard include summer living rooms, winter living rooms and eastern and western terraces (belvedere is the main component of Semnan traditional houses). These terraces have been used to watch the sky, moon and stars in spring and summer nights (Fig. 5) which has been surrounded by proper height walls to prevent strangers glance. Given the relatively proper climate of Semnan, it has been mostly constructed which can be noted to Semnan Imam Mosque (Fig.6).

**Review the facades (views)**

The first feature is their symmetry. Besides designing facilities, the reason of constructing symmetrical interior facades is to indicate the uniqueness and centrality of God in respect of religious dimension. Muslim architect always sees everything in the centre and has center-oriented thought. Unity is the key to existence. This basic principle in Islamic architecture has always caused to create shapes which has specific center which is the source of all the components (Mazlomi, Rajabali, Sep, 1987, pSep, 1987, p15).

The available symmetry in Iranian architecture (mainly central) originates from a gentle and thoughtful look which tries to make balance among different weights in the visual range of buildings (Tabasi, Reflecting Iranian identity…, p 372). It is possible to receive in respect of the national values and norms and then religious dimension (Respecting to human perception of the environment). But view divisions have its own special features. The first feature is the human divisions in the facades. For this reason, in most traditional facades, the facade divisions are 3 windowed

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room, five windowed room, seven windowed room and in individual form. This unity originates from belief in the oneness of God and classifies in religious dimension. Also, micro divisions in facade cause to create shadow in interior spaces (geographical features dimension). There are songs and the order in facade divisions is another indicator. The rhythm in respect of national values and norms dimension (respecting individual perception of the enviornment and democracy) creates a substantial impact. The rhythm is a part of life. If songs are without emphasis, short and variable, it won't conduct the observer modes in a certain path and his/her visual connection will lost (Pierre, Von Mais, To place, 2004, p 262).

Visual strength and balanced façade is related to traditional architecture components in respect of values and norms and religious dimension (respecting individual perception of the enviornment and democracy). The proportionality is to observe the size of the organism for architecture, at one hand, and livability, at the other hand and is also related to traditional and national norms.

To emphasize it in interior courtyard, it has been used wind tower in top of the hall (Fig.7). The remarkable thing in this façade is the low height of the hall; if it was constructed high, the façade proportions had been disrupted due to the hall low width. So, the architect has emphasized it by using an applicable, not useless, element namely wind tower.

## CONCLUSION

Due to the noted discussions, this kind of architecture can be considered as follow related to national and traditional values and identity dimensions in respect of using traditional architectural achievements, potential valuable principles of this relic, development of these values in architecture. Architectural elements of these values in repeating past patterns can be an indication of national and traditional cultural heritage, national myths and even national and traditional symbols. Using the symbols can be related to traditional values, national symbols and myths dimension and finally religious beliefs in decorations architecture, using symbols, democracy, avoid usefulness, self-sufficiency and introspection. Designing based on local architect principle is placed in geographical features dimension. And, geographical features in architecture would be revealed through avoid usefulness, self-sufficiency, vernacular architecture, Niyaresh (Recognition of the quality and quantity of construction materials and Iran traditional architecture) and introspection. Decorations make sence in traditional values, religious beliefs and myths, tradition, traditional and national symbols. But, in five principles of Iranian architecture including democracy (the main school of Islam reflects the fact that Islam does not allow peer worship and staying away from people). On the other hand, architecture attitude to the human is as spirit-oriented and the structure of body is the physical body that the architect makes. The architect is obliged to create the structure of body in accordance with his/her spirit:

So, three features of traditional architecture are as follow:
- The traditional architecture is the product of traditional method in designing and reconstructing and includes such as architecture which is available in the society and has been developed over time.
- Traditional architecture has patterns which reflects the society culture; has been developed over time and transferred hand to hand and generation to generation.
- Traditional architecture is related to holy issue and is somehow meaningful and valuable architecture.
  Ultimately, by studying these things in Tadayyon House, it is concluded that all elments of Iran traditional architecture has very close relationship with traditional architecture values.
  To better understanding of these elements, it is provided tables which classify these elements related to studied components.

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**Fig 1: Tadayon House**



**Fig 2- House entrance door**



**Fig 3**

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**Fig 4- Intensifying the importance of centralization in Iran traditional architecture by putting the valuable element of water**

**Fig 6: Semnan Imam Mosque belvedere          Fig 5- Tadayon House belvedere**

**Fig 7- Interior yard-wind tower**
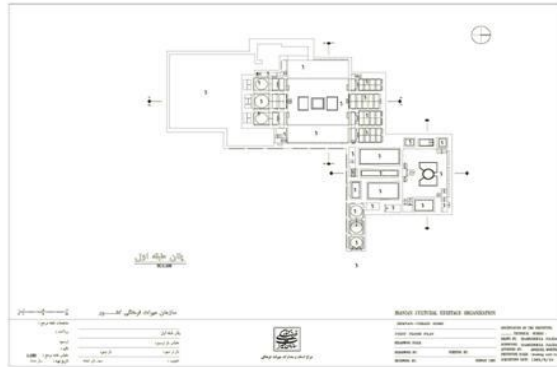
**Fig 8- Tadayon House plan**

**Table 1: The components of the traditional desert architecture in architecture**

| Tradition in architecture | Traditional architecture components (desert) | | | | |
|---|---|---|---|---|---|
| | **Traditional values and norms** | **Cultural heritage** | **religious beliefs** | **Geographic features** | **traditional and national symbols and myths** |
| Repeating past patterns | — | *** | — | — | *** |
| Using symbols | *** | — | *** | — | *** |
| Vernacular Architecture | — | — | — | *** | — |
| Decorations | *** | *** | *** | — | — |
| Democracy | *** | — | *** | — | — |
| Avoiding uselessness | *** | — | *** | — | — |
| Niyaresh | — | — | — | *** | — |
| Introversion | — | — | *** | *** | — |
| Self-sufficiency | *** | — | *** | *** | — |

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**Table 2- The components of the traditional desert architecture in Tadayon House architecture**

| Traditional architecture components (desert) | Traditional norms and values | Cultural heritage | Traditional symbols and myths | Geographical features | Religious beliefs | images |
|---|---|---|---|---|---|---|
| exterior | | | | Introspection | Attention to the nature, no windowand view to outside |  |
| entrance | Hierarchy, Two platforms on either side, Decorating entrance among the same views (hospitality) | | | Low levels of exposure against sunlight | -Different level between threshold and passage level - Respecting human as the soul of the space - Two platforms on either side |  |
| Entrance hall and vestibule | -creating waiting space - Short and arched ceiling (democracy) | | | | -Pre-space before direct entry to the inner courtyard (privacy) - hierarchy of the incoming light |  |
| outer courtyard | - house owner office - special space of guests and merchants | | | Introspection | Different level between threshold and passage level (Respecting |  |

| | | | | | the human) | |
|---|---|---|---|---|---|---|
| Interior facade | -Symmetry and balance of the façade - Rhythm and order -wind tower in the middle of façade (visual relief) | | | Micro divisions of the facade (creating shadows in the room) | -privacy -attention to the soul - Introspection -court yard spacing -façade proportions |  |
| belvedere | | | | Considering the specific climate of the region | -Visual strength - Rhythm and order |  |

**RESEARCH ARTICLE**

# Preventing and Facilitating Factors Affecting Self-Care among the Patients with Type-2 Diabetes: The Results of a Qualitative Study

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**ABSTRACT**

Self-care in diabetes can influence the risk of infecting with serious complications of the disease, prevention and also the quality of people's life. Considering the importance of self-care process for the patients infected with diabetes mellitus type 2, this study was conducted to explore and identify self-care facilitators and preventers among these patients. This is a qualitative study and was performed using content-analysis approach. The statistical sample group of the study was selected using purposive sampling method; therefore the participators were selected from the patients infected with diabetes mellitus type 2 visiting the health centers in Esfahan City, according to inclusion and Exclusion criteria. The data were collected using semi-structured interviews and with a total of 14 participants reached the saturation point. The data were gathered and analyzed simultaneously using content-analysis approach.The main concepts derived from the patients' experiences as the self-care facilitators included relatives' beliefs and support; and also the inhibitors included perceived barriers and misplaced expectations.According to the findings, it can be said that self-care in the patients infected with diabetes mellitus type 2 is dramatically influenced by the existing conditions especially in cultural, social and

economic arenas. Therefore, accurate identification of these factors may influence the effective interventions and promoting the self-care behavior.

**Key words:** Diabetes Mellitus, Self-Care, Preventing factors, facilitating factors, Qualitative Study

## INTRODUCTION

Diabetes is a growing threat to global health (1). This chronic disease is comprised of a group of metabolic disorders which have hyperglycemia phenotype in common. Regulatory metabolic disorder attributable to diabetes causes secondary pathophysiologic changes in multiple various organs of the body and this creates many health problems for both the patient and health system of the society (2, 3). The diabetes mellitus is the main cause of the end stage renal disease, non-traumatic lower limb amputation and adult's vision loss in the United States; and with the increasing prevalence of diabetes all over the world, it is expected that the disease continues to remain a leading cause of morbidity and mortality (4). Diabetes is the fifth leading cause of death in Western societies and the fourth most common reason for visiting a doctor; while 15% of health care budget in the United States is allocated to diabetes (5).According the results of a trial project which was carried out in the country from 2002 through 2009, more than 15% of men and 33% of women were at risk; and the prevalence of diabetes, in rural areas attained a high of 2.21%, and in urban areas it was almost more than twice as much as the rural areas (5%) (6). Women are infected with diabetes twice as many as men any they also are ignorant about their disease twice as much as men. These findings, along with previous data show that the prevalence of diabetes is increasing in our country and statistics show that, at present, about 11 percent of Iranians are already infected with diabetes; it is estimated that by 2015 this figure will increase twofold (7).Demographic changes and cultural transition, along with the aging phenomenon in developing countries, has caused the diabetes to become a global epidemic (8). Despite the availability of a variety of various drugs to treat and prevent long-term complications of diabetes, the reported ratio of the long-term complications is very disappointing and this is proposed as one of the most important health problems in the quality of life among the diabetic patients; therefore, one of the greatest challenges that the public health has to deal with is how to control the disease and how to prevent its complications (9). The studies have shown that the specialized medical staff cures only a small portion of chronic diseases such diabetes and most diseases are managed by the patients or their families (10, 11). Self-care is a process in which people use their own knowledge, skills and abilities as a medical source to independently take care of their health (12, 13). The aspects of self-care in diabetes patients include a wide range of self-care behaviors such as: monitoring and controlling blood glucose, insulin therapy and oral diabetes pills, sport and physical exercises, nutrition and diet nutrition, prevention of acute complications of diabetes such as hypoglycemia and hyperglycemia, Prevention of chronic complications of diabetes such as nephropathy, retinopathy, as well as foot care, smoking cessation and other health behaviors (14). Therefor, how to successfully control diabetes is mainly depended on the patients' self-care, since more than 95% of diabetes care is done by the patient. According to the available studies, lack of self-care is the most important predisposing factor for mortality in diabetic patients and infection to complications of diabetes (15). The results of various studies show that diabetic patients are facing severe problems to practice self-care. Therefore, the accurate identification of variables affecting self-care in the existing socio-cultural context is of high importance (16). Considering the important role of self-care, and adopting a holistic and qualitative approach, this study aims to explore and identify the facilitating and preventing factors of self-care in cultural, economic and social arenas.

## MATERIALS AND METHODS

This study was approved by the Ethical Committee of ShahidBeheshti University of Medical Sciences. Moreover, the approval of the respective authorities was obtained before initiating the study. Thisstudy is a qualitative study, in which content analysis method was used. The qualitative content analysis is a methodology used for mental

interpretation of textual data. This method uses systematic classification process to identify the codes and themes. The content analysis is something beyond objective content elicited from textual data; rather, it extracts the themes and hidden patterns from the contextual data of research participants [17].Research sites included health centers affiliated to the Isfahan University of Medical Sciences, Iran. Inclusion criteria were patients with definitive diagnosis of disease by a physician, record in respective health center, no chronic and severe complications, age range of 25-60 years, willingness to participate in the study, and no dementia.

The researcher attended the research site after obtaining the required permission and introduction letter, and began the selection of subjects based on research objectives and inclusion criteria (purposive sampling). Then, by introducing himself and explaining research objectives, the researcher began to obtain the informed consents of the subjects and select an appropriate place for conduction of interviews. After taking these initial measures and before conducting the interviews, the subjects were ensured about the confidentiality of their information. They were also told that they can discontinue their cooperation with the study. In addition, their consent for the recording their statements was obtained. Interviews were conducted individually once or twice, each lasted 45-60 minutes, by considering environmental and time factors, patients' conditions (degree of patience), and their willingness to participate. The interview site was a quiet room in health center for the comfort of the participants. The interviews were recorded, after obtaining the interviewees' consent. Then, they were transcribed and transferred to the analysis application word by word. As researcher should be immersed in information in a qualitative study, interviews were reviewed for several times [18]. The subjects were selected among those with the highest diversity in terms of duration of diabetes, age, gender, marital status, education, and career. The main data gathering method was in-depth and semi-structured interview with open questions. This is one of the most common data collection techniques in qualitative studies [19]. After obtaining demographic information, the researcher began the interviews by asking general questions. Some key questions included: How much do you know about diabetes? What is self-care? What are self-care behaviors that control the disease? Why should a diabetic patient consider diabetes care and control? The follow-up and in-depth questions were also asked during the interviews based on the participant's answer for better clarification of the studied concept, including: Would you please explain more? What do you mean? Would you please give me an example?

Data collection and analysis were done in six stages in line with the research objective: 1) researcher's familiarity with data, 2) generation of initial codes from data, 3) looking for themes by reviewing codes elicited in previous stages, 4) reviewing the themes and re-comparing them with data to ensure their accuracy, 5) defining and naming the themes, and 6) preparing the final report. The researcher wrote down all mental-sparks related to the data to be used in next interviews.

Data analysis was done using constant comparative approach, which is used to increase the reliability and validity of data. All participants' statements were transcribed word by word, and analyzed and coded using content analysis method. In this way, the researcher was fully immersed in data to obtain a novel perception and insight. Data analysis was initiated with frequent reading to get immersed in data and to find a general vision. The texts were then read word by word to elicit the codes. This was a continuous process from eliciting to naming the codes. After the extraction of concepts and codes from key sentences and paragraphs, they were categorized based on the similarities and differences. Finally, these classes were combined into fewer categories based on their relationship. To facilitate the main stages of the study (including open coding, axial coding, selective coding, and data analysis and interpretation), qualitative data analysis application was utilized. The first interviewed participant had 15 years history of diabetes, whose data was used in selecting the next participant. After determination of initial classes, the next participant was selected based on his/her capability in further clarification of the emerging classes. This sampling process was continued until data saturation. Although data saturation was practically achieved and the initial classes were formed after interviewing 14 participants, two additional interviews were held in case, which did not produce new information that leads to coding and formation of new classes. Finally, 16 participants were interviewed in total.During the research, some methods were used to determine the validity and reliability of the

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study. In addition, four reliability criteria (Credibility, Confirm ability, Dependability and Transferability) were employed [20]. Long-term involvement with the subject is one of the best methods for accreditation. In this study, the researcher was involved with research subject, data, and diabetic patients for one year. Data was reviewed by the participants to confirm the accuracy of data and elicited codes, and modifying them. In that, each coded interview was returned to the respective interviewee to ensure about the accuracy of the codes and interpretations, and to modify misinterpreted ones. A review was also done by supervisors. For this end, some parts of the interview's transcriptions along with the respective codes and emerged classes were sent to some supervisors to investigate and validate the analysis process. The congruence of findings was confirmed by sharing them with some external diabetic patients. The application of sampling technique with maximum diversity, which contributes to the congruence of findings or transferability of them to others, was also considered in this study. Additionally, for verifiability of the study, the researcher precisely recorded and reported the research procedure for future studies.

## RESULTS

According to the data analysis, the concepts based on the patients' experiences which were proposed as the facilitating factors in self-care were the acquaintances'' beliefs and support; and also the preventing factors were the perceived barriers and misplaced expectations.

**The beliefs:** the patient's belief is one of the factors that influence their decision to develop self-control. One of the patients says:" I believe that diabetes is a manageable disease, and with the treatment that I receive and the efforts that I make, I can control this disease." In addition, the genuine belief in the effectiveness of self-care activities encourages the patient to develop self-regulation. The patient says:" it is years that I am infected with diabetes but I have no problem with it; because I take care of myself. I believe that good nutrition, walking and exercising are very effective. On the other hand, by acting on doctors' and nurses' advice, you can reduce your blood sugar and by taking medications you can prevent the complications of diabetes."

**Acquaintances' support:"** family's and friends' support can help the patients being resolute to plan for self-care. One of the patients describes the support in this way:" well, fortunately, my wife always looks after me very well; she reminds me to take my pills; for example, in the morning, when I come out to turn my car on, she asks me whether I took my pills or not. If I had taken them, I would say yes; and if not, I would come back to take them."Another participant described the supportive role of his friends in this way:" most of my friends are not infected with diabetes, but they always call me and ask about my health. One of them told me that his grandmother had said that we should be friend with our disease. This has had a very great impact on my morale. It means that my friend advises me to make friend with my disease. For example, even once every two years, when we have a friendly get-together, they know that I should have an especial light meal."

A member of medical staff describes the support for diabetic patients in this way:" anyway, if a family knows that a person is infected with diabetes, they naturally help him with his/her nutrition, medication and activities. Actually, I mean the family should respect their presence; for example, if they cook food with low salt, fat or sugar, the rest of the family should take it easy and not to complain."

**The perceived barriers:** these are factors which are proposed as the barriers to self-care in controlling the disease.The shortage of appropriate sports facilities and the lack of financial ability make me unable to take part in sports classes such as swimming or aerobics; and insufficient insurance coverage causes me not to be able to take care of myself and to control my disease properly."One participant, whose mother had died due to diabetes type 2, was gripped by fear and anxiety and described his condition in this way:" at parties, I am embarrassed to take my medications and this has led to a disorder in my medication therapy. I do not like to be labeled as a diabetic patient; I prefer to deny my disease and hide it from others in order to be accepted in the society as a normal people."

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**Misplaced expectations:"** sometimes, due to the existing conditions, diabetic patients may have unrealistic expectations in response to others' behavior or performance and this may cause them to feel being unable to control their disease. One of the patients describes his misplaced expectations in this way:" I expect my family and my friends to support me in cooking balanced meals, choosing foodstuffs and consuming right amount of food; I also expect to have a perfect companion when I am doing my exercises; in addition, I expect them to help me in taking or buying my medications."

One of the patients expresses his expectations from the medical staff in this way:" I expect not to pay a fee for dietary advice. On the other hand, I would like to speak about my mental conditions with a confidant (e)."

## DISCUSSION

The first and most important question for the health educators and those who are involved in self-care field of the healthcare system is how can they help the help-seekers? According to Orem's self-care theory, Self-care is "the practice of activities that individuals initiate and perform on their own behalf in maintaining life, health, and well-being". Self-care is determined by the patients' carefully considered activities to regulate their performance and to promote their health and their welfare. The basic premise of the model is that individuals can take responsibility for their health; and the educators, by encouraging and educating the patients, can enable them to take care of themselves. The educators can also cause a positive impact on the quality of Patients' life (21, 22). Therefore, it is necessary to design and present the self-care models based on the perceptions and experiences of those who are involved with the issue, especially the patients. It is worth mentioning that people's experiences and perception will not remain steady in various places and different times and they change under the influence of various factors; and they required being reviewed and explained in different places and various periods of time. Scientific findings in numerous resources and studies pertinent to diabetic patients confirm the above documentations. The study findings pertinent to the self-care facilitators (beliefs, acquaintances'' support) and self-care preventers (perceived barriers and misplaced expectations) reflect the existing situations based on the patient's perceived experiences; while in a study carried out by Professor French, the beliefs about self-care behavior are as follows: the importance of doing exercise in managing diabetes, self-care behavior difficulties, and the pleasure of eating sugary or fatty foods. According to the findings, the beliefs pertinent to treatment have an important role in self-care behavior and patients' adherence to self-care. It is possible that the interventions of behavior changes can be more influential if they are being oriented to target the beliefs pertinent to behavior, not beliefs pertinent to the disease; yet its results are in harmony with the results of our study which indicate that beliefs play the role of facilitators in self-care(23). In many resources, social support is considered as one of the effective factors in self-care; however, the mechanism of this effect is still not well identified. According to self-regulation model, Austin and et al, in their study titled "a longitudinal study of a motivational dietary self-care model in the adolescents infected with diabetes" examine a model in which the independent support of parents and health care providers is effective in anticipating self-regulation and self-efficacy in self-care behavior. The results of the analysis of structural equation model suggest that the perceived support of healthcare provider in the first period of timeisthe positive predictor of self-regulation in self-care behavior in the second period of time. According to the results, independent support of the parents and healthcare providers is an effective factor to help the adolescents infected with diabetes to develop the motivational factors in order to practice dietary self-care and observe dietary recommendations (24). And this corresponds with the results of our study indicating that the family support as a facilitator influences self-care. In 2006, Klomegah also showed that, based on the majority of participants, if family members, friends and acquaintances follow a healthy diet, it will be very easy for the patients to follow a healthy diet (25); while, Cooper in his study, in 2003, showed that people infected with diabetes are in need of other people's support (26). In addition, other studies have shown that if diabetic patients enjoy social support, they will be more inclined to practice self-care (27).According to the results of our study, preventive factors can affect people to practice self-care; preventive factors are classified as the perceived barriers and misplaced expectations. In 2013, Cene in his study titled" self-care assurance as a mediator in the relationship

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between perceived social support and self-care adherence among American adults  infected with heart failure" examined the relationship between social support and perceived behavior of self-care. According to the results, better informational and emotional support has been related to self-care (28); while, our study shows that perceived support in the form of misplaced expectations has a preventive role in people's self-care. On the other hand, the patient proposes the perceived barriers as a barrier to practice self-care in controlling the disease. Abraham and et al in their study that was conducted in Bangalore in 2013, state that many patients infected with diabetes type 2 are facing tremendous challenges to undergo and implement behavioral changes to take long-term medical care and to welcome lifestyle changes and this makes it difficult for these patients to control their blood glucose levels. Accordingly, researchers believe that it is necessary to identify social factors such as disease's barriers and perceptions in self-care in patients who are infected with diabetes type 2. Therefore, researchers have conducted a cross-sectional study to investigate these factors among 60 patients infected with diabetes type 2. The results showed that the barriers of self-care and maladaptive representation of the disease are considered as two challenges to achieve the objectives of self-care (29).

## CONCLUSION

Due to the importance of self-care in managing the disease, it is necessary to have a thorough understanding of the factors associated with self-care in patients infected with diabetes in each mentioned categories. Therefore to use the findings of this study in order to promote self-care among the patients, it is necessary to develop a better understanding of the beliefs and their supportive sources in order to improve their motivation for self-regulation and also a better understanding of the preventive factors.

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**RESEARCH ARTICLE**

# Presenting a Physical Hospital Plan in Iran using Sustainable Approach

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**ABSTRACT**

Hospitals are one ofbig public buildings which consume a large amount of energy and water, and produce a lot of waste, so they are one ofindisputable priorities of sustainable design. In This paper we tried to propose a sustainable design for buildinga 150-bed hospital, theoretically with providing specifications of the physical plan.For this purpose we selected location in Amirkola town in Babol city, Iran.Using smart materials, and sustainable architecturewe can save energy and reduce environmental pollutions.

**Key words:** sustainable architecture, Hospital, Sustainable Approach,

## INTRODUCTION

Several decades have passed since the introduction of sustainable architecture, and it has proposedso many solutions to solve the contemporary crises, but stillthere are some problems for creating sustainable architecture.The aim of designing a sustainable hospital is more to attractthe attention of experts, authorities and policy-makers to the issue of energy and sustainable architecture, its importance in general, creating a context forcoherent and responsive organizations for sustainable architecture, and its current method of implementation in public places such as hospital.providing a platform for psychological comfort and improvingthe health of patients and hospital using sustainable architecture will lead to quality improvement of hospital in giving services to patients, cost reduction, stress reduction,better preservation of ecosystems,and  more secure future. Generally, based on the conducted studies, the main reasons for the increase in electrical energy consumption and fossil fuels in hospitals can be as following: lack of paying attention to power factor correction,lack of demand control, use of dark colors for rooms and corridors, the old model of electrical appliances, use of incandescent lamps, lack of suitable insulation for hot and

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cold pipes, lack of paying attention to quality control in  designing, and purchasing equipment and supplies, and so forth. In order to optimize energy in hospitals, following solutions can be made:

Use of smart glasses as insulation like  Low-E glass (Fig. 1);
Optimal use of renewable energy resources such as solar energy, photovoltaic systems or solar panels, and  biomass energy;
Using passive systems in design such as solar heating, and cooling system;
Using Building Management System  (BMS);

Optimal use of smart materials such as Thermowood(Fig.2)an exceptional natural cladding material in both classes of Thermo-S and  Thermo-D, Litracon(Fig. 3)a light transmitting concrete, Photocatalysts,Prosolve 370e(Fig. 4) athree-dimensional architectural module, Aerogel(Fig. 5) an ultra-light porous material, spray polyurethane foam(Fig. 6)an insulating plastic that is sprayed on as a liquid , Nano color insulation, and Microcell MicroporousInsulation.For more information about specifications of these materials see Addingtonand Schodek (2005), and Ritter (2007).

There are some important factors in selecting best site for a medical center like hospitals which are as follows

- Accessibility to transportation and communication lines
- Parking facilities
- Availability of public facilities
- Proper evaluation for drainage and general sanitary measures;
- Freedom from smoke, noise, vapours and other;
- Future expansion;
- Total cost.

To determine the standards of hospitals and medical centers, it should be ensured that the quality level reflects the patients and staffs' satisfaction. Correct location of the centers also leads to an increase in satisfaction and quality of life.  In this paper we tried to propose a sustainable design for building a 150-bed hospitalin Amirkola town in Babol city, Iran. In the first section we provided three examples of hospitals with sustainable design in the world, and then we presented numerical values for physical and spatial dimensions of proposed design.

**Related works**

**Suzhou children's hospital**

International architecture practice HKS designed Suzhou children's hospital in china. The program includes a 94,800 sqm children's hospital with 600 beds in the initial phase including over 7,000 sqm for outpatient clinics, 14 OR's, a full service emergency department, imaging, and required support. Other major program elements include a teaching/research and administration facility, staff housing, a separate infectious disease facility, and initial parking for 800 cars.Using Kites with bright colors and shapes soaring through the sky, the design bring wonder and joy to children of all ages.Bands of color will be interspersed on the building's façade to further designate the hospital as a place for children and their families. The design's imagery puts at ease the stress and fears of patients and their parents. Spaces are designed with the emotional and physical needs of this unique population. Infusion of natural light, well-planned clinical areas and access to multiple outside areas offer relief from anxiety and stimulates patient health.Staff will have access to garden areas set aside for their use alone. Efficiency in operation and reduction in travel distance were accomplished in the clinical, diagnostic/treatment, and inpatient areas.Ergonomic considerations were included in the design of staff work areas.Patients will arrive on foot, by bus, by bicycle, and automobile across a bridge that spans a below grade healing garden specifically designed for children and their parents arriving in a

spacious multilevel space that provides easy way-finding and access into all areas of the hospital. The use of escalators will speed the patients to the clinical areas. Each floor of the facility will have patient registration, cashier and pharmacy thus reducing congestion and unnecessary traffic patterns. Patient care areas were designed so that all patient rooms face south, in a mixture of single and 4 bed wards. The south facing rooms provide for the best balance of the healing benefits of the sun. The inclusion of a separate infectious disease building, VIP patient areas, and staff housing all lend opportunities for integrated design solutions in a child friendly environment. Figure 7 shows images of Suzhou children's hospital.

**Odense University Hospital**

Odense University Hospital (OUH), shown in Figure 8, is another example of sustainable architecture designed by Henning Larsen Architects in Denmark. This project situated close to the city center amidst a scenic old-growth forest, and uses the surrounding landscape as a way to heal its patients. The holistic facility features a light footprint that incorporates nature at every turn to create an environment replete with peace and serenity. Daylight floods in through the glass-lined buildings and rainwater will be collected to feed the many ponds and surrounding landscape. Hospital buildings at the OUH are closely clustered together in a dense circle, which is surrounded by a pedestrian ring and walkways that shoot off in spokes from the center. Visitors and patients are encouraged to stroll around the property and take in the landscape, which features dense old forests, extensive fields, hedges, ponds and channels. he western part of the property will remain completely undeveloped to maintain the feel of the countryside and provide opportunities for recreation. Even the inside of the hospital offers views of the tranquil countryside.The buildings are all designed to maximize daylighting, and their height is kept below the height of the tallest old-growth tree. Rainwater is collected from the buildings and other impermeable areas to feed into a large wet meadow that will encourage a greater biodiversity of animals and plants.

**Meyers Pediatric Hospital**

The Meyers Pediatric Hospital in Florence, Italy is an exceptional sustainable design that harnesses architecture to help the healing process. The complex is located in a park-like setting and consists of an early 20th century building updated with a new sustainable wing. With an extensive green roof, robust daylighting, and copious art and open space the hospital provides an ideal environment for healing. This hospital is designed by architects CSPE and Anshen + Allen.The hospital entrance is a three-storey traditional building that has been accurately restored.Patients first enter the original restored complex, then take a covered path through a central garden that leads to the new building's extensive atrium. Filled with light and art, the atrium's supporting columns spread out like trees. The upper glass has embedded solar electric panels to provide energy and reduce glare.

The building is set into the hillside and tiered to mix with the landscape. The effect is further enhanced by the green roof, which covers most of the building. The upper atrium features a play area that opens to the green roof to allow the children to remain connected to the outdoors. The complex was developed under the European Union's Energie Program and has successfully reduced its energy consumption by a whopping 62% for HVAC and 80% for electrical compared to a typical hospital. Figure 9 shows images of this courtesy.

**Case study: Site location**

The study site is located inImam RezaBlvd., towards Amirkolatown in Babol city, Iran.  Due to non-existence of a hospital in northern region of Babol and Amirkola, the sitewasselected so that there be an access to hospital in this point of the city.

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**Presenting Physical Planning Of the Hospital**

In this section we present specifications for various sections and spaces suggested for physical planning of a 150-bed hospital using tables including departments, areas, and units. This hospital has 23blocks.

**Block 1:**

SPACE USE: PATIENT CARE SERVICES
UNIT: 32-BED INPATIENT-INTERNAL
Table 1 shows spaces, and the suggested net areas for this block.

**Block2:**

SPACE USE: PATIENT CARE SERVICES
UNIT: 32-BED INPATIENT-SURGICAL
Table 2 shows spaces, and the suggested net areas for this block.

**Block 3:**

SPACE USE: PATIENT CARE SERVICES
UNIT: 32-BED INPATIENT-INTERNAL/SURGICAL
Table 3 shows spaces, and the suggested net areas for this block.

**Block 4:**

SPACE USE: PATIENT CARE SERVICES
UNIT: 32-BED INPATIENT-OBSTETRIC AND GYNECOLOGICAL
Table 4 shows spaces, and the suggested net areas for this block.

**Block 5:**

SPACE USE: PATIENT CARE SERVICES
UNIT: 32-BED INPATIENT-PEDIATRIC
Table 5 shows spaces, and the suggested net areas for this block.

**Block 6:**

SPACE USE: PATIENT CARE SERVICES
UNIT: CARDIAC INTENSIVE CARE (CCU)
Table 6 shows spaces, and the suggested net areas for this block.

**Block 7:**

SPACE USE: PATIENT CARE SERVICES
UNIT: INTENSIVE CARE UNIT (ICU)
Table 7 shows spaces, and the suggested net areas for this block.

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**Block 8:**

SPACE USE: PATIENT CARE SERVICES
UNIT: NEONATAL INTENSIVE CARE UNIT(NICU)
Table 8 shows spaces, and the suggested net areas for this block.
**Block 9:**
SPACE USE: HEALTH SERVICES
UNIT: SURGICAL INPATIENT
Table 9 shows spaces, and the suggested net areas for this block.

**Block 10:**

SPACE USE: HEALTH SERVICES
UNIT: MATERNITY
Table 10 shows spaces, and the suggested net areas for this block.

**Block 11:**

SPACE USE: HEALTH SERVICES
UNIT: EMERGENCY
Table 11 shows spaces, and the suggested net areas for this block.

**Block 12:**

SPACE USE: HEALTH SERVICES
UNIT: SPECIALIZED CLINIC
Table 12 shows spaces, and the suggested net areas for this block.

**Block 13:**

SPACE USE: HEALTH SERVICES
UNIT: PHYSIOTHERAPY
Table 13 shows spaces, and the suggested net areas for this block.

**Block 14:**

SPACE USE: DIAGNOSTIC SERVICES
UNIT: MEDICAL DIAGNOSTIC LABORATORY
Table 14 shows spaces, and the suggested net areas for this block.

**Block 15:**

SPACE USE: DIAGNOSTIC SERVICES
UNIT: RADIOLOGY
Table 15 shows spaces, and the suggested net areas for this block.

**Block 16:**

SPACE USE: ADMINISTRATIVE SERVICES
UNIT: ENTRANCE, RECEPTION, AND CASHIER
Table 16 shows spaces, and the suggested net areas for this block.

**Block 17:**

SPACE USE: ADMINISTRATIVE SERVICES
UNIT: MANAGEMENT, OFFICE, AND FINANCIAL
Table 17 shows spaces, and the suggested net areas for this block.

**Block 18:**

SPACE USE: ADMINISTRATIVE SERVICES
UNIT: ARCHIVE
Table 18 shows spaces, and the suggested net areas for this block.

**Block 19:**

SPACE USE: STAFF SERVICES
UNIT: DRESSING ROOM- MEDICAL STAFF
Table 19 shows spaces, and the suggested net areas for this block.

**Block 20:**

SPACE USE: STAFF SERVICES
UNIT: DRESSING ROOM- SERVICE STAFF
Table 20 shows spaces, and the suggested net areas for this block.

**Block 21:**

SPACE USE: STAFF SERVICES
UNIT: PRAYER ROOM
Table 21 shows spaces, and the suggested net areas for this block.

**Block 22:**

SPACE USE: STAFF SERVICES
UNIT: DINING
Table 22 shows spaces, and the suggested net areas for this block.

**Block 23:**

SPACE USE: SUPPORT SERVICES
UNIT: STORAGE
Table 23 shows spaces, and the suggested net areas for this block.

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## CONCLUSION

In this study, we attempted to present a sustainable design for a 150-bed hospital in Babol city, Iran. Using sustainable architecture in recent years has become more known due to the new requirements in the field of environmental issues. In addition, technological developments have offered architectures a wide range of techniques to achieve this purpose, and designers have become more aware of the role of buildings in environmental problems. Using sustainable design strategies in medical centers has many positive effects on their performance, the spatial quality of hospitals and patients' satisfaction. It also has a significant effect on reducing energy consumption. Use of smart and new materials with capabilities of production and saving energy will be a way towards sustainability and management of energy consumption in medical centers.

This is particularly true about the hospitals considering their high potentials for reducing energy consumption. Therefore, by taking additional measures to reduce energy consumption and as the time passes, we can witness optimizing energy consumption and achieving the highest level of energy saving in these medical centers, and in fact, the sustainability of energy consumption. Using smart materials, it is significantly possible to save energy and reduce environmental pollutions, however; it is essential to take necessary measures for using these materials considering the cost savings in short-term and long-term, with good, comprehensive accuracy in design process and systematically.

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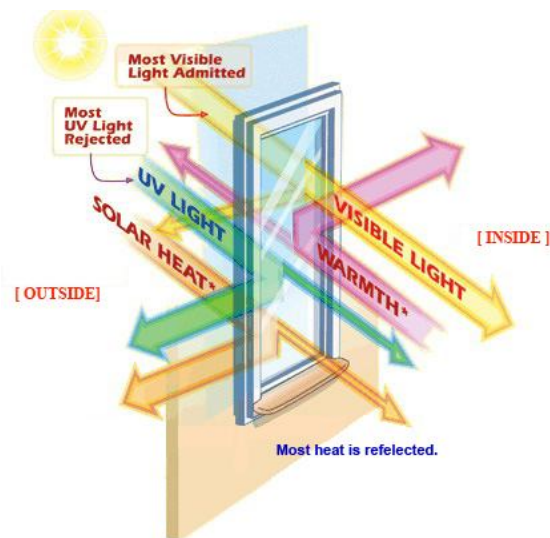
**Figure 1. Mechanism of Low-E glass (source: http://kcwindowandoor.com)**
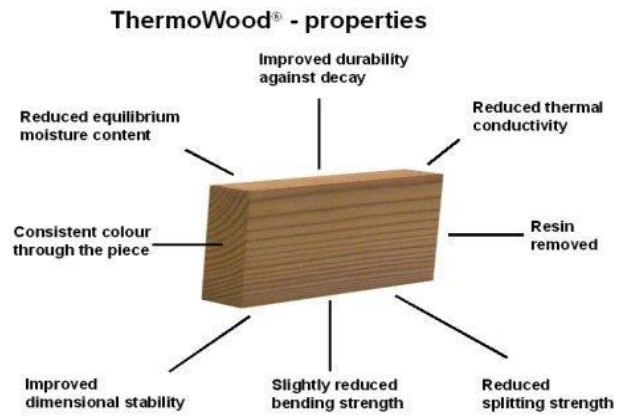
**Figure 2. Properties of Thermowood (source: www.thermowood.fi)**



**Figure 3. A Litracon concrete (Source: http://openarchitecturenetwork.org)**



**Figure 4. Prosolve 370e (Source: www.designboom.com)**

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**Figure 5. An Aerogel (source: www.onislam.net)**



**Figure 6. Spray polyurethane foam**



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**Figure 7.Suzhou children's hospital (source: http://www.archdaily.com)**



**Figure 8.Odense University Hospital (source: http://inhabitat.com)**

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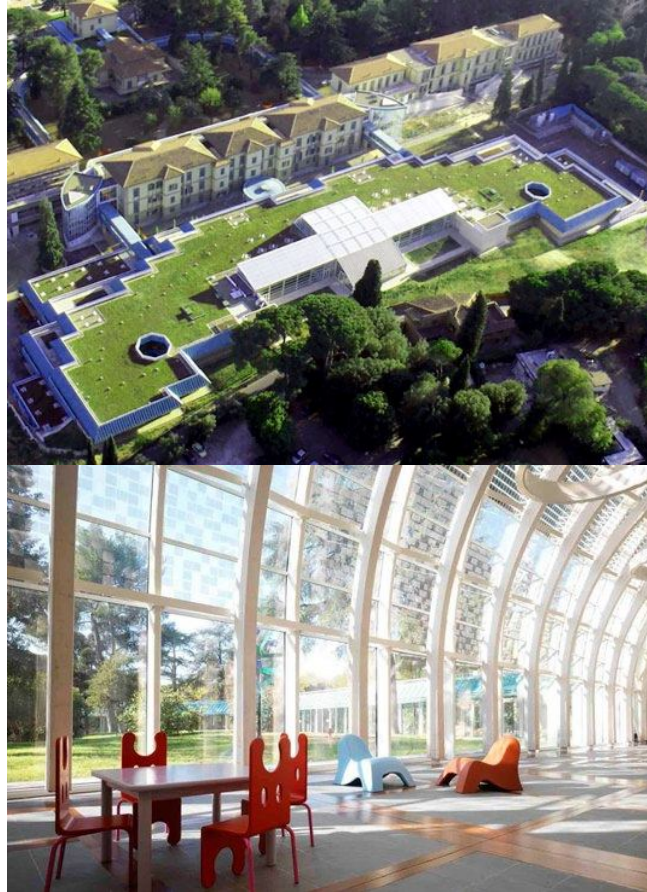


**Figure 9.Meyers Pediatric Hospital (source: http://inhabitat.com)**

**Table 1.Specifications for block 1**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Areas for patients | | | |
| 1-1 | 4-bed inpatient room with shower and separate toilet | 4+32 | 5 | 180 |
| 1-2 | Two-bed inpatient room with a bathroom | 4+20 | 5 | 120 |
| 1-3 | Single-bed inpatient room with a bathroom | 4+32 | 1 | 36 |
| 1-4 | Single-bed isolated inpatient room with a bathroom and entrance | 24 | 1 | 24 |
| 1-5 | Lavatory | 3 | 2 | 6 |
| 1-6 | Shower | 3 | 2 | 6 |
| | Support areas | | | |
| 2-1 | Nurserystation | 8 | 1 | 8 |
| 2-2 | Clean drug storeroom, work room. and linen area | 8 | 1 | 8 |

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| 2-3 | Dirty work room | 8 | 1 | 8 |
|---|---|---|---|---|
| 2-4 | Office of the Chief Nurse | 8 | 1 | 8 |
| 2-5 | Examination room | 16 | 1 | 16 |
| 2-6 | Storage | 8 | 1 | 8 |
| 2-7 | Pantry | 16 | 1 | 16 |
| 2-8 | Patients' dayroom | 12 | 1 | 12 |
| 2-9 | Wheeled Stretcher Area/ shower / toilet | 6 | 1 | 6 |
| 2-10 | stretcher and wheelchair parking area | 4 | 1 | 4 |
| 2-11 | Toilet and wash basin for staff | 3 | 2 | 6 |
| 2-12 | Cleaners room | 4 | 1 | 4 |
| | Sum of net area of two spaces | | | 476 |
| | Area of movementwithinspaces (35%) | | | 129 |
| | Net floor area | | | 605 |
| | Skeleton and walls area (10%) | | | 50 |
| | Gross floor area | | | 655 |

**Table 2.Specifications for block2**

| Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|
| Areas for patients | | | |
| 1-1  4-bed inpatient room with shower and separate toilet | 4+32 | 3 | 108 |
| 1-2  Two-bed inpatient room with a bathroom | 4+20 | 3 | 72 |
| 1-3  Single-bed inpatient room with a bathroom | 4+12 | 2 | 32 |
| 1-4  Single-bed isolated inpatient room with a bathroom and entrance | 4+4+12 | 2 | 40 |
| 1-5  Lavatory | 3 | 2 | 6 |
| 1-6  Shower | 3 | 2 | 6 |
| Support areas | | | |
| 2-1  Nursery station | 8 | 1 | 8 |
| 2-2  Clean drug storeroom, work room. and linen area | 8 | 1 | 8 |
| 2-3  Dirty work room | 8 | 1 | 8 |
| 2-4  Office of the Chief Nurse | 8 | 1 | 8 |
| 2-5  Examination room | 16 | 1 | 16 |
| 2-6  Storage | 8 | 1 | 8 |
| 2-7  Pantry | 16 | 1 | 16 |
| 2-8  Patients' dayroom | 12 | 1 | 12 |
| 2-9  Wheeled Stretcher Area/ shower / toilet | 6 | 1 | 6 |
| 2-10  stretcher and wheelchair parking area | 4 | 1 | 4 |
| 2-11  Toilet and wash basin for staff | 3 | 2 | 6 |
| 2-12  Cleaners room | 4 | 1 | 4 |
| Sum of net area of two spaces | | | 368 |
| Area of movement within spaces (35%) | | | 129 |

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| | | | |
|---|---|---|---|
| Net floor area | | | 497 |
| Skeleton and walls area (10%) | | | 50 |
| Gross floor area | | | 547 |

**Table 3.Specifications for block 3**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Areas for patients | | | |
| 1-1 | 4-bed inpatient room with shower and separate toilet | 4+32 | 3 | 108 |
| 1-2 | Two-bed inpatient room with a bathroom | 4+20 | 2 | 48 |
| 1-3 | Single-bed inpatient room with a bathroom | 4+12 | 2 | 32 |
| 1-4 | Single-bed isolated inpatient room with a bathroom and entrance | 4+4+12 | 2 | 40 |
| 1-5 | Lavatory | 3 | 2 | 6 |
| 1-6 | Shower | 3 | 2 | 6 |
| | Support areas | | | |
| 2-1 | Nursery station | 8 | 1 | 8 |
| 2-2 | Clean drug storeroom, work room. and linen area | 8 | 1 | 8 |
| 2-3 | Dirty work room | 8 | 1 | 8 |
| 2-4 | Office of the Chief Nurse | 8 | 1 | 8 |
| 2-5 | Examination room | 16 | 1 | 16 |
| 2-6 | Storage | 8 | 1 | 8 |
| 2-7 | Pantry | 16 | 1 | 16 |
| 2-8 | Patients' dayroom | 12 | 1 | 12 |
| 2-9 | Wheeled Stretcher Area/ shower / toilet | 6 | 1 | 6 |
| 2-10 | stretcher and wheelchair parking area | 4 | 1 | 4 |
| 2-11 | Toilet and wash basin for staff | 3 | 2 | 6 |
| 2-12 | Cleaners room | 4 | 1 | 4 |
| | Sum of net area of two spaces | | | 344 |
| | Area of movement within spaces (35%) | | | 120 |
| | Net floor area | | | 464 |
| | Skeleton and walls area (10%) | | | 46 |
| | Gross floor area | | | 510 |

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**Table 4. Specifications for block 4**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Areas for patients | | | |
| 1-1 | 4-bed inpatient room with shower and separate toilet | 4+32 | 1 | 36 |
| 1-2 | 2-bed inpatient room with a bathroom | 4+36 | 2 | 80 |
| 1-3 | Single-bed inpatient room with a bathroom | 4+20 | 1 | 24 |
| 1-4 | Single-bed isolated inpatient room with a bathroom and entrance | 4+24 | 2 | 56 |
| 1-5 | Single-bed inpatientroom with a bathroom | 4+12 | 1 | 16 |
| 1-6 | Single-bed isolated inpatient room with a bathroom and entrance | 4+4+12 | 1 | 20 |
| 1-7 | Lavatory | 3 | 2 | 6 |
| 1-8 | Shower | 3 | 2 | 6 |
| 1-9 | Room for caring healthy baby with 10 cradles and nurse work room (near nurse station) | 8+40 | 1 | 48 |
| | Support areas | | | |
| 2-1 | Nursery station | 8 | 1 | 8 |
| 2-2 | Clean drug storeroom, work room. and linen area | 8 | 1 | 8 |
| 2-3 | Dirty work room | 8 | 1 | 8 |
| 2-4 | Office of the Chief Nurse | 8 | 1 | 8 |
| 2-5 | Examination room | 16 | 1 | 16 |
| 2-6 | Storage | 8 | 1 | 8 |
| 2-7 | Pantry | 16 | 1 | 16 |
| 2-8 | Patients' dayroom | 12 | 1 | 12 |
| 2-9 | Wheeled Stretcher Area/ shower / toilet | 6 | 1 | 6 |
| 2-10 | stretcher and wheelchair parking area | 4 | 1 | 4 |
| 2-11 | Toilet and wash basin for staff | 3 | 2 | 6 |
| 2-12 | Cleaners room | 4 | 1 | 4 |
| 2-13 | Sit-In tubs | 9 | 1 | 9 |
| | Sum of net area of two spaces | | | 405 |
| | Area of movement within spaces (35%) | | | 142 |
| | Net floor area | | | 547 |
| | Skeleton and walls area (10%) | | | 55 |
| | Gross floor area | | | 602 |

**Table 5.Specifications for block 5**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Areas for patients | | | |
| 1-1 | 4-bed inpatient room with shower and separate toilet | 4+26 | 2 | 60 |
| 1-2 | Two-bed inpatient room with a bathroom | 4+20 | 2 | 48 |
| 1-3 | Single-bed inpatient room with a bathroom | 4+12 | 2 | 32 |
| 1-4 | Single-bed isolated inpatient room with a bathroom and entrance | 4+12 | | |
| 1-5 | Baby inpatient rooms with 5 cradle | 5 | 5 | 25 |
| 1-6 | Baby isolated inpatient room with pre-space | 4+6 | 1 | 10 |
| 1-7 | Lavatory | 3 | 1 | 3 |
| 1-8 | Shower | 3 | 1 | 3 |
| | Support areas | | | |
| 2-1 | Nursing station | 8 | 1 | 8 |
| 2-2 | Clean drug storeroom, work room. and linen area | 8 | 1 | 8 |
| 2-3 | Dirty work room | 8 | 1 | 8 |
| 2-4 | Children's play room | 10 | 1 | 10 |
| 2-5 | Milk preparation room | 6 | 1 | 6 |
| 2-6 | Examination room | 12 | 1 | 12 |
| 2-7 | Office of the Chief Nurse | 8 | 1 | 8 |
| 2-8 | Storage | 8 | 1 | 8 |
| 2-9 | Pantry | 16 | 1 | 16 |
| 2-10 | Wheeled stretcher area and shower | 6 | 1 | 6 |
| 2-11 | Stretcher and wheelchair parking area | 4 | 1 | 4 |
| 2-12 | Toilet and wash basin for staff | 3 | 2 | 6 |
| 2-13 | Cleaners room | 4 | 1 | 4 |
| | Sum of net area of two spaces | | | 285 |
| | Area of movement within spaces (35%) | | | 100 |
| | Net floor area | | | 385 |
| | Skeleton and walls area (10%) | | | 39 |
| | Gross floor area | | | 424 |

**Table 6.Specifications for block 6**

|  | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
|  | Areas for patients |  |  |  |
| 1-1 | Single-bed room | 9 | 5 | 45 |
| 1-2 | Toilet and shower for patients | 3 | 1 | 3 |
| 1-3 | Isolated inpatient room with a bathroom , toilet, and entrance | 4+4+12 | 1 | 20 |
|  | Support areas |  |  |  |
| 2-1 | Nurse and monitoring station | 6 | 1 | 6 |
| 2-2 | Clean drug storeroom and work room | 6 | 1 | 6 |
| 2-3 | Equipment and clean linen area | 6 | 1 | 6 |
| 2-4 | Dirty work room | 8 | 1 | 8 |
| 2-5 | Cleaners room | 3 | 1 | 3 |
| 2-6 | Entrance and scrub area | 7 | 1 | 7 |
| 2-7 | Night watchman | 9 | 1 | 9 |
| 2-8 | View corridor | 20 | 1 | 20 |
| 2-9 | Wheelchair and stretcher area | 2 | 1 | 2 |
| 2-10 | Toilet and wash basin for staff | 3 | 1 | 3 |
|  | Sum of net area of two spaces |  |  | 138 |
|  | Area of movementwithin spaces (35%) |  |  | 48 |
|  | Net floor area |  |  | 186 |
|  | Skeleton and walls area (10%) |  |  | 19 |
|  | Gross floor area |  |  | 205 |

**Table 7.Specifications for block 7**

|  | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
|  | Areas for patients |  |  |  |
| 1-1 | Single-bed room | 9 | 5 | 45 |
| 1-2 | bathroom and  stretcher area | 7 | 1 | 7 |
| 1-3 | Isolated inpatient room with an entrance | 4+12 | 1 | 16 |
|  | Support areas |  |  |  |
| 2-1 | Nurse and monitoring station | 6 | 1 | 6 |
| 2-2 | Clean drug storeroom and work room | 6 | 1 | 6 |
| 2-3 | supply and clean linen area | 6 | 1 | 6 |
| 2-4 | Dirty work room | 8 | 1 | 8 |
| 2-5 | Cleaners room | 3 | 1 | 3 |
| 2-6 | Entrance and scrub area | 7 | 1 | 7 |

| 2-7 | Night watchman | 9 | 1 | 9 |
|---|---|---|---|---|
| 2-8 | View corridor | 20 | 1 | 20 |
| 2-9 | Wheelchair and stretcher area | 2 | 1 | 2 |
| 2-10 | Toilet and wash basin for staff | 3 | 1 | 3 |
| | Sum of net area of two spaces | | | 138 |
| | Area of movementwithin spaces (35%) | | | 48 |
| | Net floor area | | | 186 |
| | Skeleton and walls area (10%) | | | 19 |
| | Gross floor area | | | 205 |

**Table 8.Specifications for block 8**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Areas for patients | | | |
| 1-1 | Premature babies room with two incubator and a cradle | 5 | 3 | 15 |
| 1-2 | Work room for nurses | 10 | 1 | 10 |
| 1-3 | Suspected neonates' isolated room with an incubator and a cradle | 5 | 2 | 10 |
| | Support areas | | | |
| 2-1 | Receptionand examination room for babies | 9 | 1 | 9 |
| 2-2 | Cleanersroom and Dirty storage | 5 | 1 | 5 |
| 2-3 | Entrance of scrub area | 4 | 1 | 4 |
| 2-4 | Toilet and wash basin for staff | 3 | 1 | 3 |
| 2-5 | Supply room | 5 | 1 | 5 |
| 2-6 | Lactation room | 8 | 1 | 8 |
| | Sum of net area of two spaces | | | 69 |
| | Area of movementwithin spaces (35%) | | | 24 |
| | Net floor area | | | 93 |
| | Skeleton and walls area (10%) | | | 9 |
| | Gross floor area | | | 120 |

**Table 9.Specifications for block 9**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Entrance area | | | |
| 1-1 | Entrance | 6 | 1 | 6 |
| 1-2 | Stretcherparking area | 4 | 1 | 4 |
| 1-3 | Pantry | 6 | 1 | 6 |
| | Bed substitution area | | | |
| 2-1 | Stretcher parking area | 5 | 1 | 5 |
| 2-2 | Program control station | 4 | 1 | 4 |
| | Dressing room for male staff | | | |
| 3-1 | Room space | 12 | 1 | 12 |
| 3-2 | Toilet space | 1 | 1 | 1 |
| 3-3 | Space for dressing | 4 | 1 | 4 |
| 3-4 | Space for undressing | 5 | 1 | 5 |
| 3-5 | Toilet and wash basin | 3 | 1 | 3 |
| 3-6 | Shower | 2 | 1 | 2 |
| | Dressing room for female staff | | | |
| 4-1 | Room space | 12 | 1 | 12 |
| 4-2 | Toilet space | 1 | 1 | 1 |
| 4-3 | Room for dressing | 4 | 1 | 4 |
| 4-4 | Room for undressing | 5 | 1 | 5 |
| 4-5 | Toilet and wash basin | 3 | 1 | 3 |
| 4-6 | Shower | 2 | 1 | 2 |
| | Preparation and recovery area | | | |
| 5-1 | 4-bed preparation room | 6 | 4 | 24 |
| 5-2 | 6-bed recovery room | 7 | 6 | 42 |
| 5-3 | Nursing station | 6 | 1 | 6 |
| 5-4 | Clean drug storeroom and work room | 3 | 1 | 3 |
| 5-5 | Dirty work room | 8 | 1 | 8 |
| 5-6 | Office of the anesthesiologist | 9 | 1 | 9 |
| 5-7 | Anesthesia equipment room | 9 | 1 | 9 |
| | Surgery area | | | |
| 6-1 | Surgery room | 6 | 4 | 144 |
| 6-2 | Vegan scrub room | 7 | 4 | 28 |
| 6-3 | Substerile storage | 6 | 4 | 24 |
| 6-4 | Cleaners and storage room | 5 | 2 | 10 |
| | Support areas | | | |
| 7-1 | Office of the Head of the department | 9 | 1 | 9 |
| 7-2 | The restroom for staff with pantry | 12 | 2 | 24 |
| 7-3 | supply storage | 7 | 1 | 7 |
| 7-4 | Medical consulting room | 12 | 1 | 12 |

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| 7-5 | Mobile radiology parking area with darkroom | 4+2 | 1 | 6 |
|---|---|---|---|---|
| 7-7 | Blood gas laboratory | 6 | 1 | 6 |
| 7-8 | Nursery and reportingstation | 8 | 1 | 8 |
| 7-9 | Room for disinfecting stretcher | 6 | 1 | 6 |
| 7-10 | Room for separating and washing the used surgical instruments | 6 | 1 | 6 |
| 7-11 | Cleaner room | 4 | 1 | 4 |
| 7-12 | Medical gas cylinder storage | 4 | 1 | 4 |
| 7-13 | Main sterile storage room | 24 | 1 | 24 |
| | Sum of net area of seven spaces | | | 520 |
| | Area of movementwithinspaces(35%) | | | 182 |
| | Net floor area | | | 702 |
| | Skeleton and walls area (10%) | | | 70 |
| | Gross floor area | | | 772 |

**Table 10.Specifications for block 10**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Entrance area | | | |
| 1-1 | Entrance and reception | 6 | 1 | 6 |
| 1-2 | Stretcher parking area | 2 | 1 | 2 |
| 1-3 | Obstetrics and gynecology doctors roomand examination room for parturient | 16 | 1 | 16 |
| | Labor area | | | |
| 2-1 | Preparation room for parturient with bathroom | 4+12 | 1 | 16 |
| 2-2 | Single-bed labor room with bathroom | 4+12 | 1 | 16 |
| 2-3 | 2-bed labor room with bathroom | 4+20 | 1 | 24 |
| | Delivery room | | | |
| 3-1 | Single-bed delivery room | 25 | 2 | 50 |
| 3-2 | Scrub | 6 | 1 | 6 |
| 3-3 | Substerile storage | 6 | 1 | 6 |
| 3-4 | Mother's recovery space | 10 | 1 | 10 |
| | Support area | | | |
| 4-1 | Nursery and reporting station | 6 | 1 | 6 |
| 4-2 | Clean drug storeroom and work room | 6 | 1 | 6 |
| 4-3 | Clean linen storage | 4 | 1 | 4 |
| 4-4 | Dirty workroom and storage | 8 | 1 | 8 |
| 4-5 | Supply storage | 6 | 1 | 6 |
| 4-6 | Cleaners room | 4 | 1 | 4 |
| | Area for staff | | | |
| 5-1 | The restroom with pantry | 10 | 1 | 10 |

| 5-2 | Dressing room for female staff | 9 | 1 | 9 |
|---|---|---|---|---|
| 5-3 | Shower | 2 | 1 | 2 |
| 5-4 | Toilet and wash basin | 3 | 1 | 3 |
| 5-5 | Dressing room for male staff | 5 | 1 | 5 |
| 5-6 | Shower | 2 | 1 | 2 |
| 5-7 | Toilet and hand basin room | 3 | 1 | 3 |
| | Sum of net area of five spaces | | | 220 |
| | Area of movement within spaces(35%) | | | 77 |
| | Net floor area | | | 297 |
| | Skeleton and walls area (10%) | | | 30 |
| | Gross floor area | | | 327 |

**Table 11.Specifications for block 11**

| | Space | Net area ($m^2$) | N | Total Net Area($m^2$) |
|---|---|---|---|---|
| Areas for patients | | | | |
| 1-1 | Entrance and public phone | 6 | 1 | 6 |
| 1-2 | Stretcher parking area and triage | 12 | 1 | 12 |
| 1-3 | Waiting room | 15 | 1 | 15 |
| 1-4 | Mobile toilet | 3 | 2 | 3 |
| 1-5 | Wheelchair toilet | 4 | 1 | 4 |
| 1-6 | Reception | 6 | 1 | 6 |
| 1-7 | Examination and consulting room for general practitioner | 16 | 1 | 16 |
| 1-8 | The hear-respiratory revitalization room | 18 | 1 | 18 |
| 1-9 | Room for male and female patients under treatment | 7 | 10 | 70 |
| 1-10 | Examination and treatment room | 9 | 4 | 36 |
| 1-11 | Toxic treatment room with toilet | 12 | 1 | 12 |
| 1-12 | Treatment room(sound insulated) | 12 | 1 | 12 |
| 1-13 | Room for bandage with plaster staves | 25 | 1 | 25 |
| 1-14 | Substerile | 6 | 1 | 6 |
| 1-15 | Scrub | 7 | 1 | 7 |
| 1-16 | Room for doctors on emergency dutywith toilet | 3+12 | 1 | 15 |
| Support areas | | | | |
| 2-1 | Nursery station and reporting and a clean workroom | 10 | 1 | 10 |
| 2-2 | Dirty workroom | 9 | 1 | 9 |
| 2-3 | Cleaners room | 4 | 1 | 4 |
| 2-4 | supply storage | 8 | 1 | 8 |
| 2-5 | Portable equipment area | 5 | 1 | 5 |
| 2-6 | Toilet for patients (usable for disabled) | 4 | 2 | 8 |
| Area for staff | | | | |

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| | | | | |
|---|---|---|---|---|
| 3-1 | Dressing room for female staff | 5 | 1 | 5 |
| 3-2 | Shower for female staff | 3 | 1 | 3 |
| 3-3 | Dressing room for male staff | 5 | 1 | 5 |
| 3-4 | Shower for male staff | 3 | 1 | 3 |
| 3-5 | The restroom with pantry | 9 | 2 | 18 |
| 3-6 | Toilet | 3 | 2 | 6 |
| | Sum of net area of spaces | | | 350 |
| | Area of movementwithinspaces(35%) | | | 123 |
| | Net floor area | | | 473 |
| | Skeleton and walls area (10%) | | | 47 |
| | Gross floor area | | | 520 |

**Table 12.Specifications for block 12**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Entrance and reception area | | | |
| 1-1 | The entrance | 5 | 1 | 5 |
| 1-2 | waiting room for patients | 30 | 1 | 30 |
| 1-3 | reception and cashier (two independent spaces) | 6+9 | 1 | 15 |
| 1-4 | Toilet and wash basin for staff | 3 | 2 | 6 |
| 1-5 | Toilet and wash basin for women | 4 | 2 | 8 |
| 1-6 | Toilet and wash basin for men | 4 | 2 | 8 |
| 1-7 | Toilet and wash basin for disabled people | 4 | 1 | 4 |
| 1-8 | Cleaners room | 3 | 1 | 3 |
| 1-9 | Maternal and Child Health | 16 | 1 | 16 |
| 1-10 | Vaccination room | 6 | 1 | 6 |
| 1-11 | Injection room | 6 | 2 | 12 |
| | Sum of net area | | | 125 |
| | Area of movementwithin spaces (40%) | | | 50 |
| | Net floor area | | | 175 |
| | Skeleton and walls area (10%) | | | 18 |
| | Gross floor area | | | 193 |
| | Internal clinic | | | |
| 2-1 | Sub reception room | 6 | 1 | 6 |
| 2-2 | Sub waiting room | 12 | 1 | 12 |
| 2-3 | Doctors and examination room(internal body specialties) | 16 | 1 | 16 |
| 2-4 | Doctors and cardiac examination room | 16 | 1 | 16 |
| 2-5 | Electro and eco cardiography room | 15 | 1 | 15 |
| 2-6 | Exercise room | 12 | 1 | 12 |
| | Surgery Clinic | | | |
| 3-1 | Sub reception room | 6 | 1 | 6 |

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| | | | | |
|---|---|---|---|---|
| 3-2 | Sub waiting room | 12 | 1 | 12 |
| 3-3 | Doctors and surgical examination room | 16 | 1 | 16 |
| 3-4 | Doctors and orthopedicalexamination room | 16 | 1 | 16 |
| 3-5 | Doctors and ear, nose and throat examination room | 16 | 1 | 16 |
| 3-6 | Doctors and eye examination room | 18 | 1 | 18 |
| | Children's Clinic and Maternity | | | |
| 4-1 | Sub reception room | 6 | 1 | 6 |
| 4-2 | Sub waiting room | 12 | 1 | 12 |
| 4-3 | Doctors and children's examination room | 6 | 1 | 6 |
| 4-4 | Obstetrics and gynecology doctorand obstetric examination room | 16 | 1 | 16 |
| 4-5 | Doctors and gynecology examination room with toilet and wash basin | 16+3 | 1 | 19 |
| 4-6 | Diapers changing room | 3 | 1 | 3 |
| | Dental clinic | | | |
| 5-1 | Sub reception room | 6 | 1 | 6 |
| 5-2 | Sub waiting room | 6 | 1 | 6 |
| 5-3 | Dentist hall with three units including two common units and one independent unit, and head office | 48 | 1 | 48 |
| 5-4 | Darkroom | 5 | 1 | 5 |
| | Sum of net area | | | 330 |
| | Area of movementwithin spaces (30%) | | | 99 |
| | Net floor area | | | 429 |
| | Skeleton and walls area (10%) | | | 43 |
| | Gross floor area | | | 472 |
| | Pharmacy | | | |
| 6-1 | Prescription counter | 6 | 1 | 6 |
| 6-2 | drug stagnant storage | 40 | 1 | 40 |
| 6-3 | Pharmacist room with staves for pure drugs and a place for combining drugs | 10 | 1 | 10 |
| 6-4 | Waiting room | 10 | 1 | 10 |
| 6-5 | Drug active storage | 50 | 1 | 50 |
| 6-6 | Drug delivery to the departments | 2 | 1 | 2 |
| | Sum of net area | | | 118 |
| | Area of movementwithin spaces (25%) | | | 30 |
| | Net floor area | | | 148 |
| | Skeleton and walls area (10%) | | | 15 |
| | Gross floor area | | | 163 |

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**Table 13. Specifications for block 13**

| Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|
| Reception and examination area | | | |
| 1-1  Reception and archive section | 6 | 1 | 6 |
| 1-2  Waiting room for patients | 9 | 1 | 9 |
| 1-3  Examination and therapist office | 16 | 1 | 16 |
| Therapeutic areas | | | |
| 2-1  Movement therapy hall | 8 | 1 | 48 |
| 2-2  Electro- therapy cabins(diathermy, ultrasound, Galvano-faradic, infrared and ultraviolet) | 6 | 4 | 24 |
| 2-3  Paraffin bath | 7 | 1 | 7 |
| 2-4  Cold and hot bags storage | 3 | 1 | 3 |
| 2-5  Clean linen storage | 4 | 1 | 4 |
| 2-6  Cleaners room and dirty maintenance | 4 | 1 | 4 |
| 2-7  Dressing room and patient's shower | 2+4 | 1 | 6 |
| 2-8  Toilet for patient | 3 | 1 | 3 |
| 2-9  Wheelchair toilet and shower | 4 | 1 | 4 |
| 2-10  Dressing room for staff | 6 | 1 | 6 |
| 2-11  Toilet for staff | 3 | 1 | 3 |
| Sum of net area | | | 143 |
| Area of movementwithin spaces (30%) | | | 43 |
| Net floor area | | | 186 |
| Skeleton and walls area (10%) | | | 19 |
| Gross floor area | | | 205 |

**Table 14.Specifications for block 14**

| Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|
| Areas for outpatients | | | |
| 1-1  Waiting room | 30 | 1 | 30 |
| 1-2  Reception and archive section | 6 | 1 | 6 |
| 1-3  Single bed blood sampling room | 8 | 2 | 16 |
| 1-4  Sampling toilet | 3 | 3 | 9 |
| Areas for laboratory | | | |
| 2-1  Bio-chemistry | 27 | 1 | 27 |
| 2-2  Urinalysis | 12 | 1 | 12 |
| 2-3  Hematology | 27 | 1 | 27 |
| 2-4  Microbiology, serology, parasitology | 18 | 1 | 18 |
| 2-5  Sample collecting and preparing room | 8 | 1 | 8 |
| 2-6  Eye and body shower | 1 | 1 | 1 |

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| | Support areas | | | |
|---|---|---|---|---|
| 3-1 | Public storage and preparing chemical solutions | 12 | 1 | 12 |
| 3-2 | Washing and serialization | 15 | 1 | 15 |
| 3-3 | Cleaners room | 3 | 1 | 3 |
| 3-4 | The rest room for staff | 9 | 1 | 9 |
| 3-5 | Office of the Head of the laboratory | 9 | 1 | 9 |
| 3-6 | Secretary and typist room | 9 | 1 | 9 |
| 3-7 | Dressing cabin | 3 | 2 | 6 |
| 3-8 | Toilet for staff | 3 | 2 | 6 |
| | Sum of net area | | | 223 |
| | Area of movementwithin spaces (30%) | | | 27 |
| | Net floor area | | | 290 |
| | Skeleton and walls area (10%) | | | 29 |
| | Gross floor area | | | 319 |

**Table 15.Specifications for block 15**

| | Space | Net area (m$^2$) | N | Total Net Area(m$^2$) |
|---|---|---|---|---|
| | Waiting and reception area for patients | | | |
| 1-1 | waiting room for Outpatients | 15 | 1 | 15 |
| 1-2 | Waiting room on stretcher | 2 | 1 | 2 |
| 1-3 | Reception, secretary , and archive section | 6 | 1 | 6 |
| 1-4 | Radiologist and examination room | 9 | 1 | 9 |
| | Diagnostic areas | | | |
| 2-1 | Plain radiology room with a control section | 3+25 | 1 | 28 |
| 2-2 | Dressing room for patients | 2 | 4 | 8 |
| 2-3 | X-ray fluoroscopy roomwith a control section | 3+25 | 1 | 28 |
| 2-4 | Sonography room with a dressing room | 3+12 | 1 | 15 |
| | Support areas | | | |
| 3-1 | Dark room | 6 | 1 | 6 |
| 3-2 | Light room | 10 | 1 | 10 |
| 3-3 | Mobile radiology parking area | 3 | 1 | 3 |
| 3-4 | Raw film storage | 2 | 1 | 2 |
| 3-5 | Cleaners room | 3 | 1 | 3 |
| 3-6 | toilet and wash basin for patients | 3 | 2 | 6 |
| | Areas for office and staff | | | |
| 4-1 | Dressing room (for women and men) | 3 | 2 | 6 |
| 4-2 | toilet and wash basin | 3 | 1 | 3 |
| 4-3 | Restroom and pantry | 10 | 1 | 10 |
| | Sum of net area | | | 160 |

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| | | |
|---|---|---|
| Area of movementwithin spaces (30%) | | 48 |
| Net floor area | | 208 |
| Skeleton and walls area (10%) | | 21 |
| Gross floor area | | 229 |

**Table 16.Specifications for block 16**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Hospital main entrance | | | |
| 1-1 | Entrance | 6 | 1 | 6 |
| 1-2 | Information desk | 6 | 1 | 6 |
| 1-3 | Public waiting room | 25 | 1 | 25 |
| 1-4 | Toilet for men | 3 | 2 | 6 |
| 1-5 | Toilet for women | 3 | 2 | 6 |
| 1-6 | Wheelchair toilet | 4 | 1 | 4 |
| 1-7 | Cleaners room | 3 | 1 | 3 |
| 1-8 | Phone operator's room | 8 | 1 | 8 |
| 1-9 | Insurer | 7 | 1 | 7 |
| 1-10 | Sales of flowers and gifts | 12 | 1 | 12 |
| 1-11 | Buffet | 8 | 1 | 8 |
| | Inpatient area | | | |
| 2-1 | Reception area | 8 | 1 | 8 |
| 2-2 | Patient's records room with two interview tables | 12 | 1 | 12 |
| 2-3 | Social worker room | 8 | 1 | 8 |
| | Sum of net area | | | 139 |
| | Area of movementwithin spaces (40%) | | | 56 |
| | Net floor area | | | 195 |
| | Skeleton and walls area (10%) | | | 20 |
| | Gross floor area | | | 215 |

**Table 17.Specifications for block 17**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Office areas | | | |
| 1-1 | Room for the head of the hospital and medical council | 30 | 1 | 30 |
| 1-2 | Hospital director's room | 16 | 1 | 16 |
| 1-3 | Secretary and clients' room | 12 | 1 | 12 |
| 1-4 | Room for the chief Nurse | 12 | 1 | 12 |
| 1-5 | Room for the head administrator | 12 | 1 | 12 |
| 1-6 | Secretariat | 12 | 1 | 12 |
| 1-7 | Room for Administrative staff | 12 | 2 | 24 |

| 1-8 | Administrative and personnel affairs   archive room | 12 | 1 | 12 |
|---|---|---|---|---|
| 1-9 | Meeting room | 50 | 1 | 50 |
| 1-10 | Room for Accounting and archive | 20 | 1 | 20 |
| 1-11 | Accounting manager | 9 | 1 | 9 |
| 1-12 | Discharge room and cashier | 12 | 1 | 12 |
| 1-13 | Computer and server room | 18 | 1 | 18 |
| | Support areas | | | |
| 2-1 | Printing and copy | 6 | 1 | 6 |
| 2-2 | Pantry | 6 | 1 | 6 |
| 2-3 | Toilet and wash basin (women and men) | 3 | 2 | 6 |
| 2-4 | Cleaners  room | 3 | 1 | 3 |
| | Sum of net area | | | 260 |
| | Area of movementwithin spaces (25%) | | | 65 |
| | Net floor area | | | 325 |
| | Skeleton and walls area (10%) | | | 33 |
| | Gross floor area | | | 358 |

**Table 18.Specifications for block 18**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | Office areas | | | |
| 1-2 | Statistics room | 9 | 1 | 9 |
| 1-3 | Archivistwork room | 6 | 1 | 6 |
| 1-4 | Room for archive of active medical records | 12 | 1 | 12 |
| 1-5 | Room for archive of non-active medical records | 18 | 1 | 18 |
| 1-6 | Room for archive of non-active records films | 8 | 1 | 8 |
| 1-7 | Study room | 3 | 1 | 3 |
| | Sum of net area | | | 56 |
| | Area of movementwithin spaces (25%) | | | 14 |
| | Net floor area | | | 70 |
| | Skeleton and walls area (10%) | | | 7 |
| | Gross floor area | | | 77 |

**Table 19.Specifications for block 19**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| 1 | Dressing room for male doctorsand a shower | 2+18 | 1 | 20 |
| 2 | Dressing room for female doctorsand a shower | 2+18 | 1 | 20 |

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| | | | | |
|---|---|---|---|---|
| 3 | Dressing room for nurses, healthcare workers and technicians (male and female) and a shower | 2+20 | 2 | 44 |
| 4 | Toilet and wash basin (women and men) | 3 | 2 | 6 |
| 5 | Room for attendance system and control | 6 | 1 | 6 |
| | Sum of net area | | | 96 |
| | Area of movementwithin spaces (15%) | | | 14 |
| | Net floor area | | | 110 |
| | Skeleton and walls area (10%) | | | 11 |
| | Gross floor area | | | 121 |

**Table 20.Specifications for block 20**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| 1 | Dressing room for service staff (men and women) and a shower | 2+20 | 2 | 44 |
| 2 | Toilet and wash basin (women and men) | 3 | 2 | 6 |
| 3 | Room for attendance system and control | | 1 | 6 |
| | Sum of net area | | | 56 |
| | Area of movementwithin spaces (15%) | | | 8 |
| | Net floor area | | | 63 |
| | Skeleton and walls area (10%) | | | 6 |
| | Gross floor area | | | 70 |

**Table 21.Specifications for block 21**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| 1 | Prayer hall(a space with the possibility of being separated by curtains) | 30 | 1 | 30 |
| 2 | Women's entrance and anteroom | 2.5 | 1 | 2.5 |
| 3 | Men's entrance and anteroom | 2.5 | 1 | 2.5 |
| | Sum of total net area | | | 35 |
| | Skeleton and walls area (10%) | | | 4 |
| | Gross floor area | | | 39 |

**Table 22.Specifications for block 22**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| 1 | Toilet and washbasin | 3 | 2 | 6 |
| 2 | Food distribution counter | 24 | 1 | 24 |
| 3 | Dishwasher | 12 | 1 | 12 |
| 4 | Dining hall | 84 | 1 | 84 |
| | Sum of net area | | | 126 |

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| | | | |
|---|---|---|---|
| Area of movementwithin spaces (15%) | | | 19 |
| Net floor area | | | 145 |
| Skeleton and walls area (10%) | | | 15 |
| Gross floor area | | | 160 |

**Table 23.Specifications for block 23**

| | Space | Net area (m²) | N | Total Net Area(m²) |
|---|---|---|---|---|
| | General storage | | | |
| 1-1 | Medical supplies and equipment storage | 0 | 1 | 20 |
| 1-2 | Paper and office supplies storage | 12 | 1 | 12 |
| 1-3 | Housekeeping materials and equipment storage | 12 | 1 | 12 |
| 1-4 | Miscellaneous equipment storage | 12 | 1 | 12 |
| 1-5 | Flammable materials storage | 5 | 1 | 5 |
| 1-6 | Furniture storage | 12 | 1 | 12 |
| 1-7 | Abandoned storage | 20 | 1 | 20 |
| 1-8 | Textile storage | 20 | 1 | 20 |
| | Food storage | | | |
| 2-1 | Meat refrigerator with a temperature above zero | 23 | 1 | 3 |
| 2-2 | Mean refrigerator with a temperature under zero | 8 | 1 | 8 |
| 2-3 | Vegetables and dairy foods refrigerator | 5 | 1 | 5 |
| 2-4 | Grocery store | 15 | 1 | 15 |
| 2-5 | Potato and onion storage | 5 | 1 | 5 |
| 2-6 | Room for distribution and delivery to the kitchen | 4 | 1 | 4 |
| | Sharedareas | | | |
| 3-1 | Separation and distribution room | 9 | 1 | 9 |
| 3-2 | Office ofchief warehouseman | 7 | 1 | 7 |
| 3-3 | Toiletand washbasin | 3 | 1 | 3 |
| 3-4 | Room for warehousemen | 9 | 1 | 9 |
| | Total net area | | | 199 |
| | Intra-department traffic area (20%) | | | 40 |
| | Net area of the infrastructure | | | 239 |
| | Skeleton and wall area (10%) | | | 24 |
| | Gross area of the infrastructure | | | 263 |

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**RESEARCH ARTICLE**

# Survey of HVDC Circuit Breakers in High Power System

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**ABSTRACT**

Future power transmission networks will operate closerto stability limits with points of power injection subject to rapid change as renewable sources of generation proliferate. With increasing power demands and already strained ac transmission lines, high-voltage direct current (HVDC) links are likely to see ever increasing penetration. Voltage-source converter (VSC)-based HVDC systems are becoming increasingly competitive (both financially and in terms of power losses) and provide many benefits over classic line-commutated converter (LCC)-based HVDC systems. One such benefit is the ready extension to multiterminal (MTDC) configuration.The most important drawback of VSC-HVDC systems is their need for fast HVDC circuit breakers. This paper intends at summarizing HVDC circuit breakers technologies including recent importantassays in development of modern HVDC circuit breaker. A brief functional analysis of each technology is presented. Additionally, different technologies based on derived information from literatures are compared. Finally, recommendations for improvement of circuit breakers are presented.

**Keywords:** power transmission networks, Voltage-source converter high-voltage direct current(HVDC)

## INTRODUCTION

A high-voltage, direct current (HVDC) electric power transmission system (also called a power super highway or a electrical super highway)[1-4] uses direct current for the bulk transmission of electrical power, in contrast with the more common alternating current (AC) systems. For long-distance transmission, HVDC systems may be less expensive and suffer lower electrical losses [2-4]. For underwater power cables, HVDC avoids the heavy currents

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required to charge and discharge the cable capacitance each cycle. For shorter distances, the higher cost of DC conversion equipment compared to an AC system may still be warranted; due to other benefits of direct current links.HVDC allows power transmission between unsynchronized AC transmission systems [3-6]. Since the power flow through an HVDC link can be controlled independently of the phase angle between source and load, it can stabilize a network against disturbances due to rapid changes in power [3-6]. HVDC also allows transfer of power between grid systems running at different frequencies, such as 50 Hz and 60 Hz. This improves the stability and economy of each grid, by allowing exchange of power between incompatible networks [5-6].

The main barrier against the implementation of an HVDC power grid is a high vulnerability of such grid against the DC line short circuit faults. In system fault condition, interruption of a DC fault current becomes more complex than an AC fault current. In addition to absence of current zero crossing point, because of small inductance of DC side of the systemthe rate of rise of DC fault current is considerably high and it demands for very fast interruption technology [3]. So as key technology to make the HVDC multi-terminal systems safely operational and to pave the way for integration of bulk amount of offshore wind energy to AC grid, more attention should be attracted to development of HVDC circuit breakers. DC circuit breakers, namely for high voltage applications, are not commercially and widely available today [4]. In this paper, firstly, the origin of need for HVDC circuitbreaker is explained and the main requirements of an HVDCcircuit breaker are introduced. Thereafter, HVDC circuit breaker technologies including mechanical circuit breakers with snubber, hybrid circuit breakers and also pure solid-state circuit breakers are reviewed and functional analysis of each topology is performed. Additionally, a comparison between different topologies based on results from literatures is presented. Finally, recommendations for improvement of circuit breakers are presented.

**VSC-HVDC based multi-terminal grid**

It is obvious that many of the planned offshore wind farmprojects will have a large power capacity and also they will be constructed very far from shore. Consequently, there will be a need for considerable cable length for delivering power to a receiving onshore grid [2]. Considering the distances and plants capacity, transmitting power over conventional AC cables is not feasible [3]. HVDC transmission technology was practically demonstratedin 1954 for enabling transfer of bulk amount of electricalpower at high voltage over long distances. Not only HVDC transmission lines are attractive from technical point of view but also they are economically reasonable [3]. Nowadays, there are two major HVDC technologies which practically are being used for point to point power transfer and interconnection of asynchronous electrical networks; current source converter (CSC) based and voltage source converter (VSC) based technologies [5]. In CSC systems it is necessary to install filters and additional capacitors on the ac sides and also the power flow is unidirectional and the reversal of the power-flow direction requires a change in polarity of the system, which could be problematic [5], [6]. On the other hand, VSC systems are designed based on Insular Gate Bipolar Transistors (IGBT). Active and reactive power flows are independently controllable in VSC systems and also by employing multilevel VSCs it is possible to increase the voltage and power rating of system. In VSCsystems the presence of harmonics are limited to highfrequency and this will lead to considerably smaller size of the filters. Moreover, VSC-HVDC technology transmits active power and can provide the required amount of reactive power at both the power sending and the power receiving end. This also again makes designers possible to reduce the size of filter [5], [6]. Additionally, use of VSC offers the following advantages:
• Avoidance of commutation failures due to disturbances in the AC network.
• Possibility to connect the VSC-HVDC system to a "weak" AC network or even to one where no generation source is available, and naturally, the short-circuit level is very low.
• No need of transformers to assist the commutation process of the converter's fully controlled semiconductors.
In order to ensure the security and dependability of thesesystems, the current protection philosophies and systems need to be evaluated to assess their suitability to adequately protect future HVDC systems.HVDC system protection basically involves protection ofthe converter station protection systems are more or less standard and will not be

significantly influenced by the expected changes in conventional HVDC systems. Therefore the initial studies are focused on the protection systems that are required to detect and clear dc line faults.

It must be noticed that conventional Voltage Source Converters cannot interrupt DC fault currents and DC circuit breakers are not yet commercially available for HVDC power ratings. Thus, the protection of VSC-HVDC systems is still an obstacle for the development of this technology. The features of VSC-HVDC systems make them suitable for implementing HVDC grids. Nevertheless, HVDC grids are more complex than point-to-point links. Accordingly, the fault protection of these HVDC grids is a bigger challenge due to the specific requirements of DC grids. Nowadays there is no real HVDC grid operating, but it is expected that in the near future HVDC grids will be widespread, reinforcing the predominant AC systems. In this paper, the protection required by HVDC grids is thoroughly analyzed.

In recent years, authors agreed on VSC-HVDC as the enabling technology for realization of future offshore multiterminal HVDC grid [7]-[11]. Only a few authors suggest hybrid configurations employing both CSC and VSC for development of multi-terminal HVDC networks [10].

**Requirements**

As it is mentioned before, use of VSC-HVDC for developing multi-terminal HVDC systems is ultimately advantageous but there are a few drawbacks in realizing multi-terminal systems based on VSC-HVDC. One of the concerns about the VSC systems is the power losses. Switching valves inside the VSCare responsible for large part of losses. Research activities are being carried out to reduce the losses to $\leq 1\%$[4]. As a matter of fact, the main barrier against the implementation of VSC based HVDC system is a high vulnerability of such system against the DC line short circuit faults. In VSC-HVDC system when a short-circuit fault in DC side is occurred the interruption process is much more complex and difficult than interruption of an AC fault current. The conventional AC circuit breakers interrupt the fault currents with help of zero crossing point. Since there is no zero crossing point in DC fault current so the conventional circuit breakers are incapable of interrupting the current [12]- [15]. Additionally, the anti-parallel diodes integrated with IGBT modules in VSC act as an uncontrolled rectifier even when IGBTs are turned off. For this reason the VSC becomes defenseless against a DC short-circuit fault and the fault current is only limited by AC side of VSC [16]. Moreover because of small inductance of DC side of the VSC-HVDC systems the rate of rise of DC fault current is considerably high and even in some faults the capacitors of DC link of VSC discharge and contribute to the fault current and increase rate of rise of it [17], [18]. Considering aforementioned conditions, in a multi-terminal HVDC system it is critical to interrupt the fault current and isolate the faulty line from the system. DC circuit breakers, namely for high voltage applications, are not commercially and widely available today. There are many significant requirements for design of efficient and operational HVDC circuit breakers. The most important requirements of an HVDC circuit breaker with capability of operation in future multi-terminal HVDC system can be listed as following:
• Create a current zero crossing to interrupt the current (In case of conventional hybrid and mechanical circuit breakers).
• Very fast breaking action (Because the rate of rise of DC fault current is very high and delay in interruption will lead to a destructive fault current in system.)
• Minimal conduction losses (a small voltage drop across the terminals of circuit breaker should appear and the normal operation losses in comparison to other elements of system should be reasonable.)
• Reliable and efficient protection against all types of faults(including pole to ground and pole to pole faults)
• Repetition of switching operation (be capable to reclose after a fault clearance)
• Prevention of excessive overvoltage (be able to suppress the switching overvoltage and demagnetizing the system inductance).
• Minimal arcing after contact separation to reduce contact erosion (in case of mechanical or conventional hybrid circuit breakers)

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• Provide enough isolation capability due to system ratings.
• Long lifetime
• Less need for maintenance and in case of need be capable of
bypassing the current to prevent the service interruption.

**HVDC circuit breakers**

In this section different HVDC circuit breakers are classified and a brief functional analysis of each topology is presented.

**Mechanical HVDC circuit breaker**

*a.   Mechanical passive resonance CB*

The mechanical HVDC circuit breaker with passive resonance circuit is an old technology and initially was developed for CSC-HVDC systems [19]. Fig.1 shows a simplified diagram of mechanical circuit breaker.Typically, CB is an air blast circuit breaker with several interrupter units. During normal operation current flows through the CB and during interruption it is commutated into commutation path. For understanding the interruption process it is necessary to analysethe current equation during the process. The differential equation of during interruption can be written as below:

$$L_c \frac{d^2 i_c}{dt^2} + \left( R_c + \frac{\partial u_{arc}}{\partial i_s} \right) \frac{di_c}{dt} + \frac{1}{C_c} i_c = \frac{I_0}{C_c} \qquad (1)$$

*b.   Mechanical active resonance CB*

In the active mode, a current oscillation provided by the prechargedcommutation capacitor $C_c$ will arise instantly and it will grow to oppose the current in the main $CB$ when the current is commutated into the $LC$ branch. In some texts, this scheme is also introduced as hybrid interruption method. Generally, in these types of circuit breakers thyristors are employed to act as commutator and disconnector switches. This concept is also known as two-stage interruption method. Although there are several variants for this concept, here two basic topologies are presented [20], [21]. Fig.2 depicts the first variant of mechanical active resonance circuit breakers.

In the first topology and under normal load conditions, only the main breaker $S_1$ is closed while the other switches $S_2, S_3$ and $S_4$ are in open state. The capacitor $C_c$ is pre-charged with a negative initial voltage $V_{c0}$. As soon as a fault current is detected $S_1$ is opened and simultaneously $S_2$ and $S_3$ are closed. Then the reverse current arising through $S_4$ branch opposes the fault current and when it reach the equal amount of fault current a zero crossing will happen and the current will be commutated to the parallel branches. After charging the $C_c$, current inside the $S_2$ will fall to zero and it opens. Subsequently, the switch $S_4$ closed discharging the capacitor $C_c$ into the loop $C_c - S_4 - S_3 - L_c - C_c$. When a current-zero occurred in $S_3$, it turns off and the main current commutated again into the path including $R_{lim}$   $S_4$   $S_3$   $L_c$   $C_c$. The switch $S_4$ opens when a current-zero is created resulting in a new energy balance in which the capacitor is fully charged. Interrupting the nominal rated current could be realized for the second variant by closing only the switch $S_3$. Fig.3 shows the second topology of conventional hybrid circuit breakers.After fault detection in the second variant, the main breaker , is opened and simultaneously ⬚⬚is closed to create a zero current inside the main breaker. Finally ⬚⬚will naturally open  after capacitor is fully charged.

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**Hybrid Technologies**

Integrating controllable solid-state devices with a mechanical breaker or disconnector in a combined configuration is called the hybrid switching technique. Generally, within a hybridcircuit breaker, the commutation path is introduced by solidstateswitches and only operates during the interruption process. All the switches are controlled by electronic circuits. Recent developments in semiconductor switches and improvements in their characteristics such as break-down voltage, conduction losses, switching time and reliability, bring about the possibility of using these devices as the main interrupters in circuit breakers. There are several possible topologies for hybrid circuit breakers, but in practice, two main structures attract more attentions. Fig.4 shows the first basic hybrid topology.

In this topology a fast mechanical breaker is equipped with a set of solid-state switches in the parallel path. This topology combines low losses of a pure mechanical breaker with fast switching response of a pure solid-state device. Since the arc chamber must only create sufficient voltage for commutation and not artificial current zero crossing point, this topology is faster than conventional circuit breakers. Application of this topology has been developed for medium voltage grids [22], [23], [24]. Another topology which has been introduced in [14] employs a fast solid-state device in the main path of current and in series with a fast mechanical disconnector. The parallel path is built by series connection of solid-state switches. The fast solid-state device in the main path can be an IGBT. This IGBT needs only to create a sufficiently high voltage for the commutation of the current to the parallel full IGBT breaker so it has lower rating than the parallel path breaker. Typically, it can be realised by connection of a few number of IGBTs in series so the conduction losses and voltage drop will be low enough. During the normal operation, the current will only flow through the bypass and the current in the main breaker is zero. When a DC fault occurs, the auxiliary DC Breaker immediately commutates the current to the main DC Breaker and the fast disconnector opens. With the mechanical switch in open position, the main DC breaker breaks the current. The mechanical switch opens with zero current and low voltage stress. The fast disconnectorwill be exposed to the recovery voltage defined by the protective level of the arrester banks first after being in open position while the main DC breaker opens. A simplified schematic of this topology is depicted in Fig. 5.

**Pure solid-state circuit breaker**

Fast and ultra-fast switching time of semiconductor devices make them a very strong candidate for DC fault interruption. A pure solid-state circuit breaker can be faster than all other topologies. Design of pure semiconductor based circuit breakers is possible by different combinations of solid-state switches and ancillary circuits. Considering proposed topologies in literatures there are two major topologies for this type of circuit breakers and other structures can be classified within one of these topologies. Generally, in pure solid-state circuit breakers many IGBTs, IGCTs or other semiconductor based switches are connected in series and parallel to support the voltage and current of system during normal and fault conditions. Researches with aim to optimize and improve the behaviours of solid-state circuit breakers are on-going and new contributions are also reported [25], [26].

*a.    CB paralleling a surge arrestor*

Fig. 6 depicts a typical circuit configuration of a solid-state dc circuit breaker [25]. The semiconductor switch acts as the main breaker and a surge arrestor is connected in parallel with it. During normal operation is in on-state and conducts the current from source to the load. As soon as a short-circuit fault is detected will be turned off. Then the load current commutates to the surge arrestor. Surge voltage across is limited to the clamping voltage of the surge arrestor . The clamping voltage of surge arrestor is assumed as and also it is assumed that the impedance of the fault point is negligibly small.

*b.*     *CB with freewheeling diode*

As another topology of hybrid circuit breakers, a freewheeling diode and a varistor are connected across the DC line. The circuit reduces the energy absorbed in the breaker with suppressing the surge voltage across the valve device . A circuit configuration of the solid-state dc circuit breakers using a freewheeling diode is shown in Fig.7. During normal condition, remains on and leads the load current. When turns off at after detecting a fault, the fault current  is commutated to. Hence, the current flowing through immediately decreases to zero. The inductance is gradually demagnetized by , and the fault current decreases. When the clamping voltage of is expressed in  , the surge voltage across is which is the sum of nominal DC voltage and the clamping voltage. Because does not supply any power after turning off , the energy absorbed in the DC breaker at turn-off operation is equal to the energy stored in by the current.

## CONCLUSION AND RECOMMENDATIONS

Nowadays, the main obstacle against the realisation of HVDC grids is lack of mature HVDC fault current breaking technologies. In this paper the present technologies of HVDC circuit breakers were summarised and compared. All of presented breaking schemes have limited capabilities in interruption of permanent fault current and need to be significantly improved. In terms of mechanical circuit breakers as the basic devicesfor fault current interruption, attempts should be concentratedin optimization of size of resonance circuit's elements. Also the behaviour of arc chamber needs to be improved to reach higher current rating. Since hybrid circuit breakers present more efficiency and acceptable interruption speed, the development of faster mechanical switches with high surge voltage withstand and low concoction losses can lead to more improvements in this area. In terms of solid-state circuit breakers, application of new wide-band-gap semiconductors like SiC or GaN based switches should be investigated. Also active gate driving technologies can improve the performance of semiconductor switches in pure solid-state circuit breaker. Moreover, accurate dynamic models for semiconductor switches with validity in high voltage and high currents to be used in designs and simulations are necessary to be implemented. In order to provide the possibility of distinguishing the permanent faults from transient grid events applications of DC fault current limiters in HVDC networks can be interesting to study.

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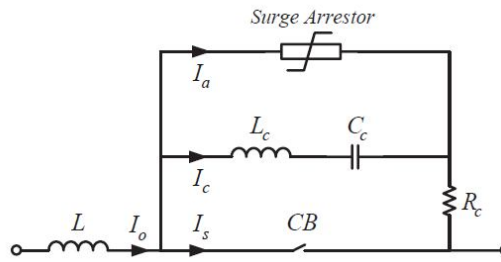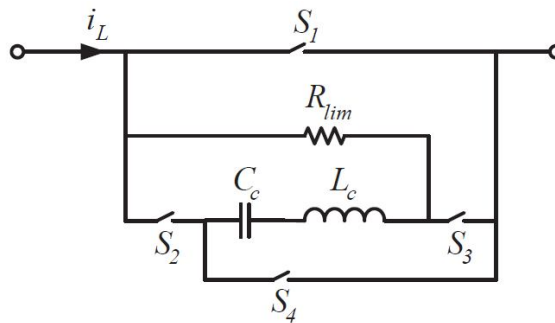
**Fig1. Mechanical HVDC circuit breaker**



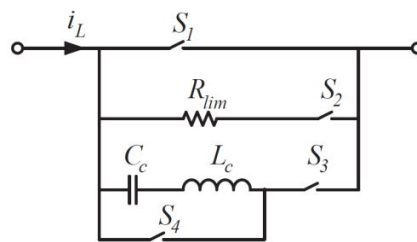**Fig.2 The first variant of active resonance circuit breakers**
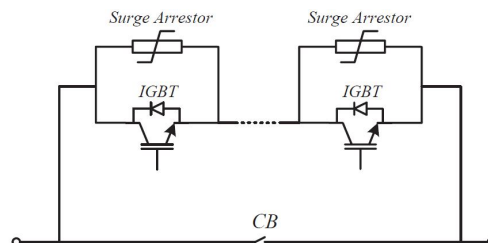


**Fig.3 Variant 2 of active resonance circuit breakers**



**Fig.4 Topology 1 for hybrid circuit breaker**

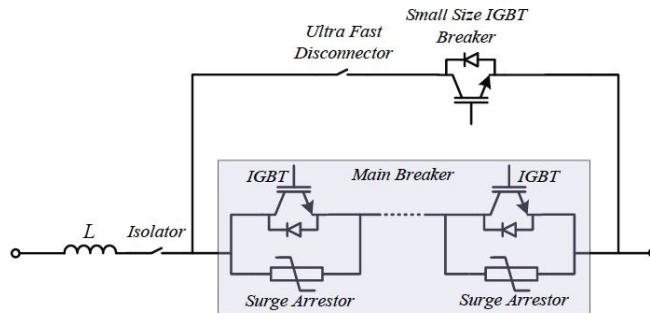**Abdolkhalegh Hamidi *et al.***



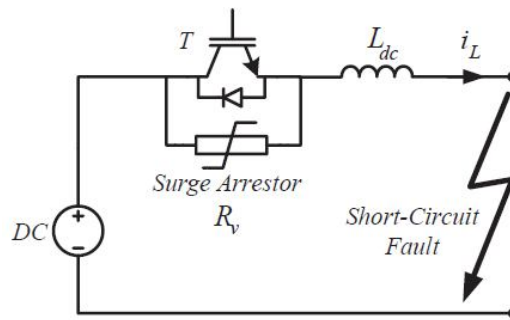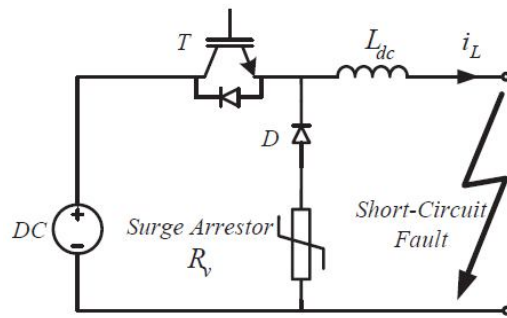**Figure 5: Topology 2 for hybrid circuit breaker**



**Fig.6 Topology 1 for solid-state CB**



**Fig.7 Topology 2 for solid-state CB**