TEHRAN UNIVERSITY OF MEDICAL SCIENCES

IJOH INTERNATIONAL JOURNAL OF OCCUPATIONAL HYGIENE
Copyright © 2008 by Iranian Occupational Health Association (IOHA)
2008-5435/14/63-1-8

IRANIAN OCCUPATIONAL HEALTH ASSOCIATION IOHA

ORIGINAL ARTICLE

Prioritization of the Green Buildings̓ Criteria

HEDIEH CHOROM [1], NABIOLLAH MANSOURI [2*], MOHAMMAD HASSAN BEHZADI [3]

[1] *Department of Environmental Management, Science and Research Branch, Islamic Azad University, Tehran, Iran*
[2] *Department of Environmental Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran*
[3] *Department of Statistics, Science and Research Branch, Islamic Azad University, Tehran, Iran*

Received November 13, 2019; Revised July 11, 2020; Accepted July 29, 2020

This paper is available on-line at *http://ijoh.tums.ac.ir*

ABSTRACT

Construction industry as one of the main industries has different effects on natural resources, environment, and health. Therefore, this study was conducted to identify and prioritize green buildings̓ criteria in the Iranian metropolises. In the current study, the green buildings̓ criteria and sub-criteria were extracted through a literature review on Science Direct database, interviewing with the specialists, and using the Delphi model. Then, the extracted criteria were weighted and prioritized using analytic network process (ANP) and Super Decisions software. Based on the findings, 8 main criteria and 26 sub-criteria were extracted to identify and prioritize the green buildings̓ criteria. The results showed that education, culture, energy management, water management, waste management, wastewater management, materials, and indoor and environmental quality of the building were among the most important green buildings̓ criteria. Application of these criteria prior to construction will enable the city managers to design a sustainable and green city and avoid interference of the non-specialists and personal tastes in construction of the green buildings.

KEYWORDS: *Green Building, Criteria, Analytic Network Process, Management, Administration, Environment*

INTRODUCTION

Nowadays, buildings are getting bigger so that, the total area of buildings built on this planet is about one-sixth of the water area including rivers, lakes, seas, and oceans. This growth in construction industry requires different energy sources [1]. Studies have shown that construction industry has the largest proportion for consumption of natural resources with the highest effect on the environment [2]. This industry is consuming 40% of the world's resources, 12% of drinking water reserves, 55% of wood products, 40% of raw materials, and producing 45 - 60% of global waste. According to the previous

Corresponding author: Nabiollah Mansouri
E-mail: nmansourin@srbiau.ac.ir

studies, production of harmful greenhouse gases in this industry is 48%, which in addition to climate change and air pollution, it can also create the risk of losing natural resources [3-4].

The concept of green building has been considered in the last two decades more than ever, because solutions for the global problems including energy and water shortage, and waste collection are dependent on construction processes. Up to now, various definitions of green building have been provided. Generally, green building is referred to a "way to minimize the environmental effects of building as a whole and at the same time focusing on its biological, environmental, economic, and social effectiveness" [6-7].

Today, construction industry faces with two major challenges around the world. The first challenge is the use of conventional sources of energy, which are becoming increasingly expensive. The second one is the environmental damages that can occur as a result of constructing the buildings - for example, air, water, and soil pollution, carbon emissions and other greenhouse gases, and damage to plants and other natural habitats [5-8]. However, evidence shows that green design can help the builders to meet both of these challenges. Not only it can have a positive effect on public health and the environment, but also it can reduce operating costs, increase marketing in construction industry, propagate resident productivity, and prepare a sustainable community [9].

Construction industry has been identified as one of the largest consumer of natural resources, 30-40 % of global energy consumption, responsible for 30-40% of energy-related greenhouse gas emissions, and accounting for about 12% of water consumption and almost 45-60% of waste [10-11] thus, construction industry is the largest section with energy and water savings opportunities too [12].

Accordingly, green building assessment could be an important tool to encourage sustainable development in construction sector. Assessment systems for green building have led to emergence of a new model of the environmental building design [13].

Numerous studies have investigated obstacles and possible solutions to support greenhouse revolution [14]. Yas and Jafar [4] in their study introduced the lack of experience, increasing the costs and required time, inefficient governments̓ support ,and the lack of knowledge and demand among the investors and users as the existing obstacles for development of green buildings [5]. Huo et al., described the five basic factors in green buildings as follows: 1- attention to protection of the environment, 2- effective use of space and natural and available resources, 3-green parking, 4- green ambient temperature and finally, 5- the use of earth's resources [15]. Tazkia et al., [6] introduced the criteria for green process management including air pollution control, environmental management, environmental costs, green image, and green products [16].

Barat and Haji Babaei, in a study on weaknesses and opportunities for green buildings showed that government strategies and policies including granting facilities and loans for novel construction industry would be the best strategies and approaches to improve green building industry in Iran [17]. Nekouei et al., in their study about challenges and opportunities of green building concluded that strategic orientation of government policy on the cost of green building is the best option and is an important issue to develop this industry [18]. Moradi Ahari identified the main criteria to achieve sustainable housing including access to basic facilities and services, profitability of economic activities, access to public transportation system, environmental pollution, quality of green belts and gardens, proper aggregation, strength and quality of housing, performance and efficiency of energy in building, as well as its identity, vitality ,and security [19].

Meybudy et al., in a study on prioritization of green schools̓ criteria in Iran showed that managerial features are the most important parameters in evaluating green schools [20]. Habib et al., after ranking parameters influencing energy consumption in buildings showed that windows and related materials are the first priority in energy saving of building [21]. Araqi, Ardeshir, and Behzadian also in a research on assessing the possibility of reduction of water consumption in a green building showed that the best strategy to implement the existing regulations and solutions is imposing heavy financial punishments, such as increasing water cost and municipal taxes [22].

Therefore, in this study, it is attempted to use analytic network process (ANP) in order to create a scientific support and a logical approach for selecting and developing a green building. Quantification of these criteria and showing their use enables the city managers and policymakers to take steps toward sustainable and green buildings. Also, it can decline wrong choices and also avoid interference of the non-specialists and personal tastes in construction of the green buildings. Benefiting from private sector investment, sponsorships, and support from leading companies can be a big step toward accomplishing this goal.

Tehran (Iran̉s capital) as a pioneer city in the use of environmentally friendly buildings has already established the Green Building Union. Also, the first green building in Iran was constructed in Tehran; thus this city was chosen to study prioritization of the green buildings̉ criteria.

Finally, it should be mentioned that the novelty of this study is design and creation of a native and standard questionnaire to investigate the criteria of green buildings in Iran. This study provides a basis for identifying and prioritizing important factors in development of a green building and creating relationships between these criteria, which will be presented in the form of modeling in the next stage of the study.

MATERIALS AND METHODS

This study was a descriptive - exploratory study and statistical population of this study included the managers and experts of Tehran Municipality Organization. Herein, the required criteria (standards) for green building were measured by specific surveys and interviews. Totally, 11 expert/connoisseur members were selected from the experts in the field of environmental protection. All the members had the related expertise and knowledge and were familiar with topic of green building. All of them at least had 5 years of working experience in their organizations. In this study, the main goal was identification of green buildings̉ criteria from the perspective of Tehran Municipality Organizations̉ experts. Required data were collected from library and web sources. Then, according to the previous studies, green buildings̉ criteria were identified by the experts̉ opinions using Delphi model (standard questionnaire). In the next step, the experts̉ opinions were integrated; therefore, methods were used for aggregation of the experts' opinions and geometric average was used for this purpose. Then, the matter was divided into the criterion and sub criterion levels in order to find the relationships between them.

Finding inter-criterion relationships is so important in this step. If there is a mutual relationship between the criteria, it will be considered as a network model. In this case, ANP technique should be used. Data collection tool in this level is a self-administered questionnaire for paired comparison so that, opinions of the experts were collected by the 9-point Likert scale reliability of which was determined using incompatibility rate and its validity was determined by content analysis with the help of the experts in this field.

For performing ANP technique, at first, the main criteria were compared in pairs based on the purpose. Pair comparison is very simple and all elements of each cluster should be compared in pairs. For performing pair comparisons and creating priority vectors in the ANP, decision elements of any part should be compared with respect to their importance for the control criteria and the parts are also should be compared with regard to their effect on the main goal.

The decision-makers were questioned by a series of paired comparisons and their effects. Also, if there was any relation and interaction between decision elements of one part, its effect was indicated on other elements using paired comparisons and making special vector for each element. Relative importance was also achieved using relative scale. Fig. 1 shows the research levels and data analyzing process using Super Decisions software.

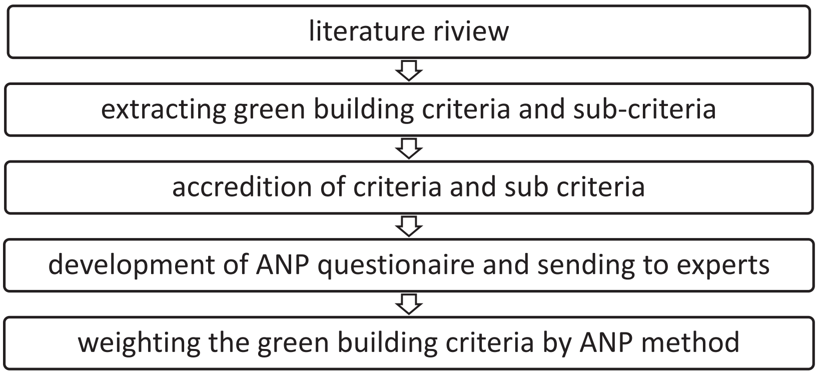

Fig 1. Research Steps

Super Decisions software is decision-making software working based on two multi-criteria decision-making methods.

ANP is implemented in the Super Decisions software and has been applied to various problems related to decision-making. It is a combination of two parts. The first part consists of a control hierarchy or network of criteria and sub-criteria controlling interactions in the system under study. The second one is a network of influences among the elements and clusters.

Applications may be simple, consisting of a single network, or complex, and also a main network and two or more layers of sub-networks. Each network and sub-network is created in its own window [23].

Steps to build an ANP hierarchical decision model using the Super Decisions software are presented below.

This study was categorized as a study with scale development design and a combination of field and library methods were used to collect the required data. For achieving the primary list of the related criteria, firstly, library and web resources were used, the questionnaires were completed and the experts̓ group meetings were held and in the next step, the two-stage Delphi method was implemented to ensure correct selection of effective criteria for the green buildings (in accordance with local conditions).The Delphi method is known as a communicative process allowing the specialists to participate in complex topics effectively [24-25].

Related studies about Delphi method in urban issues have suggested employing of 8-12 members as an optimal number of members for two-stage Delphi method [26]. Because the number lower than this may lead to loss of necessary data; and also more members may cause confusion in analyzing the results [27]. In this regard, an 11-member group including university professors and related experts (employed in different parts of municipality and environmental protection organizations) was developed and then, experts' opinions were questioned by a two-stage questionnaire about each criterion and sub-criterion.

In the first stage, the questionnaire entitled as “The Criteria Influencing Performance of Green Building “including primary criteria and sub-criteria was e-mailed to the experts. For determining the importance of each criterion, the 9-point Likert scale was used and the members were asked to rate importance of any criterion in a scale ranging from insignificant (1) to very important (9). Also, they were told that if they think any of criteria has no relationship with study objectives, they can specify it by ticking "Delete Criterion" option. Also, they were told that they could add other suggested criteria at the end of list too.

In the second stage, results of analyzing the first questionnaire were reported in specific column in the second questionnaire and the members were again asked to rate according to the averaged results. Criteria with lots of “Delete Criterion” requests were specified to make new decision about them. Second questionnaire was e-mailed to the experts again and data were analyzed finally.

RESULTS AND DISCUSSION

Standard criteria for green building were determined with regard to the related available global criteria in order to accommodate them with Iran's conditions and quantifying any selection criterion. Also, during inclusion of criteria, recognition, applicability, and ease of use were considered in assessing process to ensure practicality and performance. In the first step, screening and identification of the required standards for green building were performed. Based on the literature review and special interviews for screening and identification of final criteria, Delphi model was used so that, according to below tables, totally, 8 main criteria and 26 sub-criteria were identified.

Table 1. Green building Criteria and sub-criteria

Row	Criterion	Sub- criterion	Row	Criterion	Sub- criterion
		Use of solar energy			Strength and stability of the building against vibration
		Building orientation			The beauty of the building
	Energy consumption management	Brightness reduction systems			Fire alarm and extinguishing system
		High energy activities			
		Cooling and heating systems	6	Indoor quality	Air conditioning system
		Type of energy saving lamps			Thermal and acoustic insulation
		Reduction in water consumption			green space irrigation method
	Water consumption management	Installation and inspection of counter and leakage control			Building parking
		Gray water separation system			green space of sector
		Rainwater collection system			Proximity to public transport
	Waste Management	Existence of a reduction waste And production plan	7	Environmental quality of the area	Existence of suitable space To play Kids
		Waste segregation			Existence of a convenient route for walking and cycling
	Sewage management	sewage disposal method			sector parking
	material	Renewable and environmentally friendly materials	8	Education and culture	

Consequently, all the identified indicators were used as green buildingś criteria. After identification, these elements were classified into 8 categories including energy consumption management, water consumption management, waste management, waste water management, materials, indoor space quality, environmental quality, education, and culture. As mentioned before, ANP was used to prioritize the green buildingś criteria.

For weighting the green buildingś criteria, ANP approach was used. Final weight for criteria is shown in Figure 2.

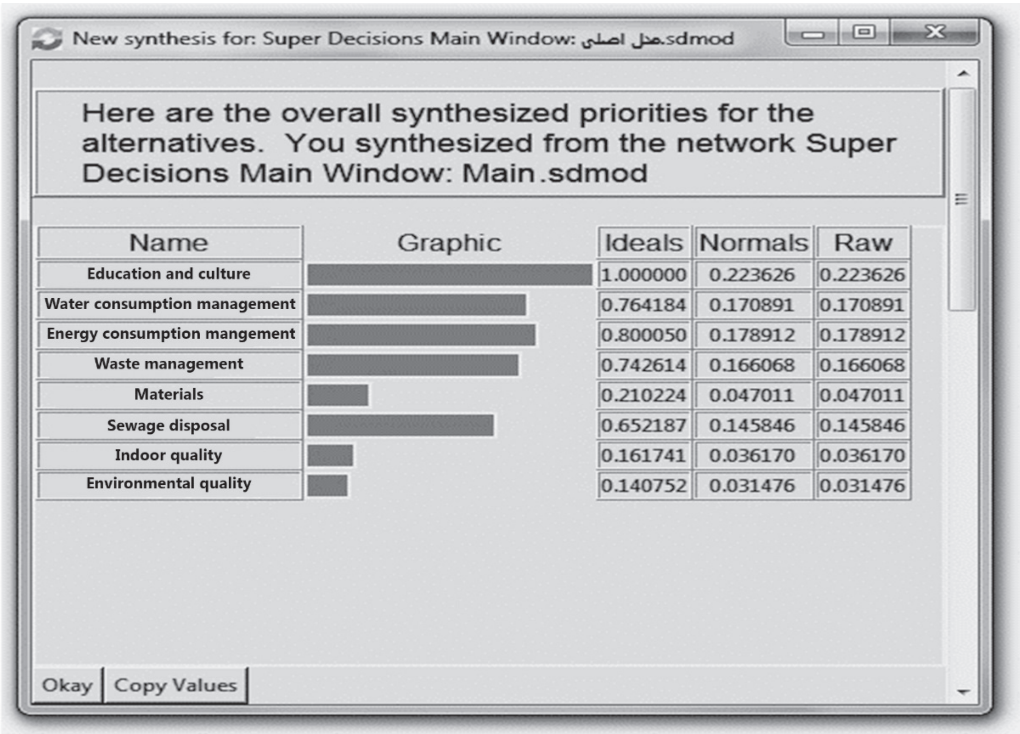

Fig 2. Prioritization of Green Building Criteria

Table 2. weighting green building criteria and sub-criteria

Row	The main criterion	Weight	Row	Sub criterion	Weight	incompatibility rate
	Education and culture building	0.223626		No sub- criteria		
2	Energy consumption management	0.178912	2-1	Use of solar energy	0.293 478	0.098
			2-2	Building orientation	0.214 384	
			2-3	Cooling and heating systems	0.194368	
			2-4	High energy activities	0.115967	
			2-5	Type of energy saving lamps	0.095524	
			2-6	Brightness reduction systems	0.086279	
	Water consumption management	0.170891	3-1	Reduction in water consumption	0.486958	0.09
			3-2	Installation and inspection of counter and leakage control	0.213623	
			3-3	Gray water separation system	0.156821	
			3-4	Rainwater collection system	0.142598	
	Waste Management	0.166068	4-1	Existence of a reduction waste And production plan	0.666667	0
			4-2	Waste segregation	0.333333	
	Sewage management	0.145846	5-1	sewage disposal method	sub-criterion	
	material	0.047011	6-1	Renewable and environmentally friendly materials	sub-criterion	
	Indoor quality	0.036170	7-1	Strength and stability of the building against vibration	0.426834	0.054
			7-2	Fire alarm and extinguishing system	0.170434	
			7-3	Thermal and acoustic insulation	0.133247	
			7-4	Air conditioning system	0.113620	
			7-5	green space irrigation method	0.063619	

		7-6	Building parking	0.060657	
		7-7	The beauty of the building	0.031589	
Environ mental quality of the area	031 476	8-1	Proximity to public transport	0.356767	0.062
		8-2	sector green space	0.305000	
		8-3	There is a suitable space for children and teenagers to play	0.120231	
		8-4	Sector parking	0.112286	
		8-5	Existence of a convenient route for walking and cycling	0.105716	

As shown in Table 2, the main green buildings̓ criteria were education and culture, energy consumption management, water management, waste management, wastewater management, materials, quality of indoor space, and environmental quality, respectively.

In the detailed prioritizing of the green buildings̓ criteria, sub-criteria were also mentioned as below:

Energy Consumption Management:

Using solar energy, orientation of the buildings, and cooling and heating systems, respectively;

Water Management:

Reduction of water usage, installation and checking the water consumption counter, leakage control, and the availability of system for gray waters;

Waste Management:

Planning to reduce waste production and finally, waste separation;

Quality of the Indoor Space:

Stability and sustainability of the buildings against vibration, fire alarm and extinguishing system, and thermal and acoustic insulation;

Environmental Quality:

Distance to public transportation, availability of the green areas, and suitable places for children and adolescents̓ playing were among the prioritized sub-criteria, respectively.

DISCUSSION

Identification of the factors influencing performance of green buildings is very important in making basic decisions for design of green buildings. The previous studies have reported about effective technologies for site design and its future developments. However, no comprehensive analysis has been done about important green buildings̓ criteria. Hence, this study was implemented aimed at identifying and prioritizing the important factors in green building design as a result of which, 8 main criteria and 26 sub-criteria were selected and analyzed finally.

The results showed that education and culture are of the highest priority among green buildings̓ standards. As the environment has been made based on cultural indicators, therewith environmental problems always have a cultural root. Education is one of the essential strategies to rectify these problems. Education is the major tool for making social change, revolution, and development and is the most effective factor in changing behavior, insight, and attitude of the people and in this context, human resources is one of the important bases for environmental protection. In fact, the issue of culture and its influence on the environment is one of the main aspects of sustainable development and it is the first step to fulfill this goal. For achieving the mentioned goals, there is a need to establish the concept of environmental culture, as a type of culture that recognizes changing and complex communications and reacts to them sensitively. For creating this type of culture, revision should be made in the educational and cultural methods and systems. Thus, providing the required education is necessary to change behavior and create an environmentally friendly culture.

Energy management is the second priority for design of green buildings. In accordance with this result, today we can see rising cost of energy and importance of energy management in the building much more than before. In this regard, for minimizing the negative effects on the environment, different ways have been applied, such as optimizing location of the building, using energy conservation methods, optimizing orientation of the building, and design and control of indoor colors to maximize the use of natural light [28]. Considering this priority is in accordance with reduction of energy consumption, producing less greenhouse gases, and the use of renewable energy sources. Therefore, conserving energy resources, preventing soil and environmental pollution, reducing fossil energy consumption by finding climate potentials, and using renewable energy are among the main goals of new architects, civil engineers, and environmental engineers.

Water management was ranked the third among green buildings̉ criteria. According to the previous studies, there is a need for fundamental changes in humans̉ activities, especially in relation to the concept of sustainability and sustainable development in all the humans̉ activities and also consumption of natural resources to reduce the effects of global warming and climate change [29-30]. Sustainability criterion usually is used in ranking of the buildings including various aspects of water management ,such as water usage, reducing water consumption, monitoring of water usage, using efficient connections (and pipes), and efficient use of gray water and rainwater [31]. Availability of these systems can help to reduce production of waste water also it may improve shortage of water and local protection of the environment [32]. The use of the systems for collecting and treating the rain water can lead to more efficiency and better management.

Waste management had the fourth priority among green buildings̉ criteria. According to the world health organization (WHO), solid waste disposal is one of the most important problems caused by urban, rural, and industrial development. Waste disposal is known as one of the most important and common methods to control this problem, because this method is simpler and cheaper than other methods, while there is no need for sophisticated technology and skilled labor [33]. Solid waste management includes various methods to reduce the volume of solid waste including reuse, recycling, and reduction of waste production at source and composting stages [34]. In green buildings, the use of sustainable materials, such as recycled glass and steel, as well as the use of recoverable materials like bamboo and plastic can help in better waste management.

Waste water management was selected as the fifth priority in green buildings. Although in developed countries, waste water control is almost at standard level, but in the low- and medium-income countries, still there are major problems about waste water management [35] so that, prior studies have shown that approximately 4 billion of the world's population (two-third of total population) have no access to waste water system; [36] because most of the countries still prefer the water supply to waste water sanitation (and its direct profit to indirect one) [37]. In green buildings, creating waste water collection and treatment system and reuse of water from the process like using flash tank, cooling tower, and watering the plants would reduce the risks related to release of waste in nature, which in turn retains more sources of water and declines the cost of water consumption.

Building materials was ranked the sixth among green buildings̉ criteria. Generally, renewable materials and compounds are used more than non-renewable compounds in construction of green buildings because, their influences are considered during the building's life. In addition, green building materials generally reduce maintenance and replacement costs over the buildings̉ life, conserve energy and improve health and productivity of the buildings̉ occupants. Green building materials can be evaluated by characteristics ,such as reuse, recovery, reduction or zero emission of harmful gases, reduction or removal of toxicity in materials, the ability for rapid and continuous renewability, the use of local materials, recyclability, durability ,and longevity [38]. A green building is designed with regard to the use of natural materials, the ability and ease of use of local materials, lack of using toxic substances, and energy efficiency [39].

The seventh rank in green buildings̓ criteria was given to one of the most important components of humans̓ benefits related to green building, "the indoor environmental quality (IEQ)". [7] IEQ is dealt with release of volatile organic compounds and other pollutants in interior space of the building [40]. Thus, IEQ is one of the prominent features in green buildings̓ evaluation tool [41]. Lee Mann and Bordas (2007) also showed that green buildings̓ users tend to be more tolerant than the users of conventional buildings in terms of indoor quality [42]. Building users̓ satisfaction is closely related to thermal comfort, which is a complex dynamic of temperature and humidity [43-44-45]. This concept has encouraged many researchers to simulate and measure the level of thermal comfort in green buildings compared to conventional buildings. Psychological, physiological, cultural, and behavioral factors can also play an important role in adaptation with thermal comfort [46]. Finally, the results showed that environmental quality of the region had the least priority among green buildings̓ criteria. Urban environmental quality (UEQ) is a concept derived from human and nature-related factors that works spatially at different scales [47]. It is also an indicator for measuring the degree of suitability of the environment and is a multi-dimensional feature [48]. Generally, in accordance with the WHO, UEQ [11] is one of the main dimensions of quality of life that focuses more on physical and natural environment [49]. Urban environments provide areas where people are exposed to incompatible environmental conditions, such as noise, air pollution, external security, congestion, and the lack of facilities therefore, management of urban environments is vital [50].

It should be mentioned that because statistical population of the study included the experts, university professors, and managers with related education, limited access to them and their time limitations to complete the questionnaires were the main limitations of this study. As a result, there was a need for making repeated calls and sending emails in order to have access to them.

Another limitation of the research was the lack of scientific and applied resources in the field of green building studies in Iran and other countries, which can be attributed to the novelty of this field. According to importance of this issue, it is predicted that proper scientific resources will be published gradually around the country and world.

For addressing the scientific knowledge gaps in the field of green buildings̓ criteria, it is suggested to prioritize the green buildings̓ criteria by other techniques and its results can be compared with the results obtained from the ANP method.

CONCLUSION

According to the above-mentioned results, it can be concluded that, education and culture, energy management, water management, waste management, wastewater management, materials, and buildings̓ indoor quality and environmental quality are among the most important criteria for green buildings, respectively.

Thus, the following suggestions can be helpful:

- According to importance of education and culture in the field of green buildings, review of the new ideas and standpoints about environmental protection highlights the fact that changes in life style can provide a suitable environment for life and work, with the less negative ecological effects.
- Identification, cooperation, and partnership with the groups, forums, unions, and local organizations to restore the existing buildings or designing and constructing new green buildings (for example, buildings for environmental protection organizations, factories, and universities)
- Compilation and publishing the examples from green buildings (best practices) for public and persuading and encouraging them to develop green buildings
- Encouraging scientific associations, universities, and counseling executives and centers to create thought and design rooms for elaborating on green buildings' scopes
- Due to high capacity of energy saving in the country and specialized activity of energy optimization, "Energy Services Insurance" will

help to create strong business climate in the energy sector.

- The government can reward the builders and buyers to motivate them for development of green buildings. In other words, the builders and buyers can receive subsidies for several years. The government also must ensure that the Standards Institute maintains its authority on endorsing implementation of the standards.

ACKNOWLEDGEMENT

I would show my gratitude to my co-authors who not only helped me during this project but for sharing their pearls of wisdom with me during the course of this research, and I thank all of municipality and environment organization experts and employees for their good participation and comments in this project. Finally, any errors are my own and should not tarnish the reputations of these esteemed persons.

REFERENCES

1. Askari, I. B., Ameri, M. Techno-economic feasibility analysis of stand-alone renewable energy systems (PV/bat, Wind/bat and Hybrid PV/wind/bat) in Kerman, Iran. Energy Sources, Part B: Economics, Planning, and Policy. 2012; Vol. 7(1), pp. 45-60.
2. Matthews, E., Amann, C., Bringezu, S., Fischer-Kowalski, M., HÃttler, W., Kleijn, R. The weight of nations. Material Outflows from Industrial Economies. 2000; Washington, DC: World Resources Institute.
3. Roodman, DM. Lenssen, N. A Building Revolution: How Ecology and Health Concerns Are Transforming Construction. Worldwatch Paper. 124. 1995; Worldwatch Institute. Washington, USA.
4. Castro-Lacouture, D., Sefair, JA. Florez, L., Medaglia, AL. Optimization model for the selection of materials using a LEED-based green building rating system in Colombia, Building and Environment. 2009; Vol 44, pp. 1162-1170.
5. Yas, Z., Jaafer, K. Factors influencing green building projects spread in the UAE. Journal of Building Engineering. 2019; Vol 27. Doi: https://doi.org/10.1016/j.jobe.2019.100894.
6. Glavinich, T.E. Contractor's guide to green building construction: management, project delivery, documentation and risk reduction. 2008; John Wiley & Sons.
7. Kruger, A., Seville, C. Green building: principles and practices in residential construction. 2012; Cengage Learning.
8. Pandey, S. Impact of green building rating systems on the sustainability and efficacy of green buildings: case analysis of green building index, malaysia. 2018.[(accessed on 24 August 2019)].
9. Fowler, KM., Rauch, EM. Sustainable building rating systems- summary. (The Pacific Northwest National Laboratory) operated for the U.S. Department of Energy by Battelle .2006; PNNL-15858.
10. Wang, W., Zmeureanu, R., Rivard, H. Applying multi-objective genetic algorithms in green building design optimization. Building and environment. 2005; Vol. 40(11), pp. 1512-1525.
11. Woo, J.H., Menassa, C. Virtual retrofit model for aging commercial buildings in a smart grid environment. Energy and Buildings. 2014; Vol 80, pp. 424-435.
12. Caputo, P., Pasetti, G. Overcoming the inertia of building energy retrofit at municipal level: The Italian challenge. Sustainable Cities and Society. 2015; Vol 15, pp. 120-134.
13. Mateus, R., BraganÃ§a, L. Sustainability assessment and rating of buildings: Developing the methodology SBToolPTâ€“H. Building and environment. 2011; Vol. 46(10), pp. 1962-1971.
14. Gou, Z., Lau, S.S.Y. Contextualizing green building rating systems: Case study of Hong Kong. Habitat International. 2014; Vol 44, pp. 282-289.
15. Huo, X., Ann, T., Darko, A., Wu, Z. Critical factors in site planning and design of green buildings: A case of China. Journal of Cleaner Production. 2019; Vol 222, pp. 685-694.
16. Tuzkaya, G. l., Ozgen, A., Ozgen, D., Tuzkaya, U. R. Environmental performance evaluation of suppliers: A hybrid fuzzy multi-criteria decision approach. International Journal of Environmental Science & Technology. 2009; Vol. 6(3), pp. 477-490.
17. Bart, S., haji babaee, A. Investigating the Weaknesses and Opportunities of Using Green Buildings in Tehran Using method pest,swot and Network Analysis Process (ANP) Quarterly

Journal of Engineering and Construction Management. 2016; Vol. 1(1), pp. 20-27. (in Persian)
18. Nekui, M., Barat, S., Taherkhani, R. Challenges and Opportunities for Using Green Buildings in Iran Using SWOT and Network Analysis Process (ANP), Second International Conference on Civil, Architecture and Urban Economics Development. NARON Managers Training Institute. Shiraz. Iran. 2015. (in Persian)
19. Moradi, A.A. Ranking of Sustainable Housing Criteria Using the ANP Method, International Conference on Management and Social Sciences. Dubai, Viera Capital Idea Managers Institute. 2015. (in Persian)
20. Meibodi, H., Lahijanian, A., Shabiri, M., Josie, A., Azizinejad, R. Developing Standard Criteria for Green Schools in Iran, Journal of Education. 2016; Vol. 32 (3), pp. 107-129. (in Persian)
21. Habib, F., Barzegar, Z., Chashmeh, Gh. M. The Necessity of Green Building Implementation in Iran and Comparison with Today's Common Buildings. National Conference on Iranian - Islamic Architecture and Urban Development. Mashhad. 2014. (in Persian)
22. Iraqi, M., Ardashir, A., Behzadian, C. Assessment of the Ability to Reduce Household Water Consumption in Green Buildings Based on LEED Scoring Model. Fifth Iranian Water Resources Management Conference. Tehran. Iran Water Resources Science and Engineering Association. Shahid Beheshti Univer. 2013. (in Persian)
23. Saaty , TL, The Analytic Hierarchy Process (AHP) for Decision Making and The Analytic Network Process (ANP) for Decision Making with Dependence and Feedback : SUPER DECISIONS. 2003.
24. Miller G. The development of indicators for sustainable tourism: Results of a Delphi survey of tourism researchers. Tour Management. 2001; 22 (4): 351–62.
25. Hugé J, Le Trinh H, Hai PH, Kuilman J, Hens L. Sustainability indicators for clean development mechanism projects in Vietnam. Environ Dev Sustain. 2010; 12: 561–71.
26. Novakowski N, Wellar B. Using the Delphi technique in normative planning research: Methodological design considerations. Environ Plan A. 2008; 40 (6): 1485–500.
27. Choi HC, Sirakaya E. Sustainability indicators for managing community tourism. Tour Manag . 2006; 27 (6): 1274–89.
28. Khorrami, M., Mooaveni, S., Mishkah, R. H. The Necessity of Green Building Implementation in Iran and Comparison with Today's Common Buildings. National Conference on Iranian-Islamic Architecture and Urban Development. Mashhad. 2012. (in Persian).
29. Asif, M. Growth and sustainability trends in the buildings sector in the GCC region with particular reference to the KSA and UAE. Renewable and Sustainable Energy Reviews. 2016; Vol 55, pp. 1267-1273.
30. Khan, M., Asif, M., Stach, E. Rooftop PV potential in the residential sector of the Kingdom of Saudi Arabia. Buildings. 2017; Vol. 7(2), pp. 46.
31. Shimizu, Y., Dejima, S., Toyosada, K. CO2 emission factor for rainwater and reclaimed water used in buildings in Japan. Water. 2013; Vol. 5(2), pp. 394-404.
32. Sernobeh, S., Sernobeh, S., Vasaee-chaharmahali, S. Rotation and Reuse of Gray Water in Green Water Consumption Management. First National Conference on Drinking Water Supply and Demand and Sanitation. Challenges and Solutions. Isfahan University of Technology. 2016. (in Persian)
33. Pichtel, J. Waste management practices: municipal. Hazardous, and industrial: CRC press. 2005.
34. Dan'azimi, J., Bin Sipan, I., Sapri, M., Aliyu Shika, S., Isa, M., Abdullah, S. 3R's Critical Success Factor in Solid Waste Management System for Higher Educational Institutions. 2012. Procedia- Social and Behavioral Sciences 65.
35. Wilderer, P.A., Schreff, D. Decentralized and centralized wastewater management: a challenge for technology developers. Water Science and Technology. 2000; Vol. 41(1), pp. 1-8.
36. Mara, D. Appropriate wastewater collection, treatment and reuse in developing countries. Paper presented at the Proceedings of the Institution of Civil Engineers-Municipal Engineer. 2001.
37. Jackson, H. Global needs and developments in urban sanitation. Low-Cost Sewerage. 1996. Chichester: John Wiley & Sons.
38. Howe, J.C. Overview of green buildings. National Wetlands Newsletter. 2010; Vol. 33(1), pp. 3-14.

39. Woolley, T., 2010. Natural Building-a guide to materials and techniques.
40. Yu, C.W.F., Kim, J.T. Building pathology, investigation of sick buildings VOC emissions. Indoor and Built Environment. 2010; Vol. 19(1), pp. 30-39.
41. Yu, C.W., Kim, J. T. Building environmental assessment schemes for rating of IAQ in sustainable buildings. Indoor and Built Environment. 2011; Vol. 20(1), pp. 5-15.
42. Leaman, A., Bordass, B. Are users more tolerant of â€˜greenâ€™buildings? Building Research & Information. 2007; Vol. 35(6), pp. 662-673.
43. Zhang, Y., Altan, H. A comparison of the occupant comfort in a conventional high-rise office block and a contemporary environmentally-concerned building. Building and environment. 2011; Vol. 46(2), pp. 535-545.
44. Mekhilef, S., Safari, A., Mustaffa, W., Saidur, R., Omar, R., Younis, M. Solar energy in Malaysia: Current state and prospects. Renewable and Sustainable Energy Reviews. 2012; Vol. 16(1), pp. 386-396.
45. Bisoniya, T.S., Kumar, A., Baredar, P. Experimental and analytical studies of earthâ€“air heat exchanger (EAHE) systems in India: a review. Renewable and Sustainable Energy Reviews. 2013; Vol19, pp. 238-246.
46. Djongyang, N.l., Tchinda, R., Njomo, D. Thermal comfort: A review paper. Renewable and Sustainable Energy Reviews. 2010; Vol. 14(9), pp. 2626-2640.
47. Nichol, J., Wong, M.S. Modeling urban environmental quality in a tropical city. Landscape and urban planning. 2005; Vol. 73(1), pp. 49-58.
48. Kaili, D. Fuzzy Evaluation of Urban Environmental Quality: Case Study Wuchang. 2003. Wuhan.
49. Joseph, M., Wang, F., Wang, L. GIS-based assessment of urban environmental quality in Port-au-Prince, Haiti. Habitat International. 2014; Vol. 41, pp. 33-40.
50. Van Poll, H.F.P.M., 1997. The perceived quality of the urban residential environment: a multi-attribute evaluation.