

Ecological Analysis of High-Rise Buildings by Eco City Theory (Case Study: Mashhad Metropolitan)

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Abstract

The construction of urban ecological buildings is the symbol of ecological urban sustainable development. High-rise buildings that signify the development level of cities are the most important type of urban ecological buildings. This paper emphasizes on the improvement of the quality of construction and reduction of resource consumption and energy waste in large-scale construction including high-rise buildings in Mashhad metropolitan as the second metropolis in Iran. HQE (High Quality Environmental standard) refers to an international standard for sustainable and green architecture, and serves as a fundamental principle for design of high-rise buildings with emphasis on eco city theory in this paper. The comparison of three important and famous existing high-rise buildings in Mashhad according to designing principles of ecological high-rise buildings is the ultimate goal of this paper. The presented data in this paper relate to all towers of Mashhad metropolitan and the case studies are three towers of Baran, Armitaj and Darvishi Hotel. In this paper, using analytical and descriptive methods, 40 criteria, and 14 secondary targets in 4 basic target groups of "ecological construction", "ecological management", "Comfort" and "health" in two main groups of external and internal environment have been assessed and the final scores represent the level of greenness of buildings. Evaluation of completed questionnaires and interviews with managers, residents and a group of designing engineers indicate that almost none of the towers have considered the eco city principles and are non-ecological buildings. The implementation of a few criteria of HQE parameters in these towers are not due to the ecological thinking in construction but to show that these towers can provide distinguishable welfare for inhabitants compared to other buildings and also to construct a more expensive building to demand a higher price for sale. In order to improve the quality of high-rise buildings and further delineation of ecological thinking, we suggest considering all levels of management, planning and design of eco cities in construction of high-rise buildings.

Keywords: Eco City Theory, High-Rise Buildings, HQE, Mashhad.

1. Introduction

Every year, more than 100 million square meters of residential, commercial and official buildings with the approximate cost of 133 billion dollars are constructed in Iran. Despite the fact that 25 percent of Iran's income is being spent in housing construction, the useful life of the constructed buildings is too short, while, the useful life of buildings in many developed countries is more than 200 years (Standard office of Khorasan Razavi, 2010).

Meanwhile, high-rise buildings which are the newest type of constructions, at first were the sign of technological progress of societies that signified the development level of developed cities and were built to combat severe population growth and shortage of land for the construction of new housing units (Etemad, 2011). But gradually the energy crisis and environmental pollution in metropolises, led to changes in urban construction policies (Rahnama & Abbas Zade, 2006) and the construction of high-rise buildings became the necessity for big cities.

On the other hand, the expansion of the construction industry, the influence of modern architecture and complex problems in the environment make the state of the world in the 21st century testifies to an unsustainable development (Gorji, 2010). Hence the field of ecological issues like ecological planning and ecological cities was provided and preliminary ecological design, ecological parks, ecological architecture and urban planning, was entered into the urban planning system (Rahnama & Razzaghian, 2013).

So Sustainable Architecture was appearing in associated with comprehensive solution for environmental considerations and also to enhance the quality of life and cultural, economic, social values (WGSC, 2004). In the case of buildings, sustainable design refers to resource efficiency, minimal energy, flexibility and long life (Rogers, 2007). Therefore the distinctive feature of the third millennium is planning with nature and principles of sustainable development in all activities related to urban issues (Pearce, et al, 1989).

As an example we can mention to different developed countries like Singapore, China, America, Germany, Britain and South Korea where ecological planning is in the top of government policies (Travati, 2012). First they express the slogan of sustainable development and then by organizing the Green and Ecological Movements they try to reach the sustainable development. Singapore government consider policies like "The Second Master Plan of Green Buildings" as a progressive plan in sustainable development, the main purpose of this plan is to reach at least 80 percent of buildings become green by 2030 (Wong, et al., 2011).

In addition in developed countries like Germany, government has fundamental role in promoting sustainable development in ecological parts. Furthermore, in a common program, German and China governments perform the project of Eco-City in Shenzhen city of China in line with Planning and management, so we can say that local organizations have essential role in Development of ecological thinking (Moughtin, Shirley, 2007).

This paper aims to improve the quality of construction, reduce resource consumption and energy waste in vast part of construction and high-rise buildings in Mashhad metropolitan as the second metropolis in Iran with 2807464 populations. HQE indicators as one of the

international sustainable standards and green architecture, that mean "High Quality Environmental" uses in this article as Fundamental principles, and Eco city Theory and design criteria of high- rise buildings are used too. The comparison of the principles with three important and famous high-rise buildings which named Baran, Armitaj and Darvishi Hotel specified the difference. Also it has clarified the ecological thinking in high-rise building. The hypothesis of the research is that there is no possibility of ecological thinking and green architecture building in Mashhad high-rise towers.

1.1. International Standard of HQE¹

HQE is an optional standard to develop efficient and sustainable buildings which aims to promote buildings that are environmentally responsive and profitable, and healthy places to live and work (Etemad, et al., 2008). HQE index actually seek a balance between the impact of greenhouse gases and resource constraints on one hand and user demands for comfort and safety of the other hand (Ghalenoyi, 2011). This approach is not a mandatory aspect for manufacturers, employers and others and have implemented voluntarily (Yudelson, 2009). In this way both indoor and outdoor focused simultaneously and the concerns of its buildings in general are the health and welfare of residents with the aim of saving resources and reducing wastes in the environment (Kubba, 2009).

This approach considers all parts of building throughout its life cycle and due to its flexibility, can be used in all kinds of constructions. This approach can also be operating in all different climates (Duchene-Marullaz, et al., 2001).

Ecological indicators considered for the design of high-rise buildings in the study have been classified into two major categories of external and internal environment. Then four basic target groups, 14 secondary targets and 40 indexes are used. The goals specified in the table below.

Table 1- Ecological indicators in High-Rise buildings

Categories	Basic Target Groups	Secondary Targets
External Environment	Ecological Construction	1. Harmonious relationship of building with its surrounding environment
		2. Select appropriate construction materials and native products
		3. Construction site with minimal disturbance
	Ecological Management	4. Energy management
		5. Water management
		6. Waste Management of activities
		7. Management of maintenance and preservation of building
Internal Environment	Comfort	8. Comfort in temperature and humidity
		9. Acoustic comfort
		10. Visual comfort
		11. Smell comfort

¹ - Haute Qualite Environmentale (French expression)

	Health	12.The sanitary quality of spaces
		13.Air quality
		14.Quality of water

Source: Duchene-Marullaz, et al., 2001

The indicators are used in this research are extracted from HQE international standard, national regulations of building (particularly article 19), saving energy studies (Abbas Zadeh & Hosseini, 2011) and global successful examples which have international awards for sustainable design.

2. Materials and Methods

Using analytical and descriptive methods, 40 indexes, and 14 secondary targets in 4 basic target groups of "Ecological Construction", "Ecological Management", "Comfort" and "Health" in two main groups of external and internal environment have been assessed and the final scores represent the level of greenness of buildings. Evaluation of completed questionnaires with 62 questions (open and closed questions) and interviews with managers, residents and a group of designing engineers (21 members) indicate the status of ecological thinking in high-rise buildings. This information is collected in two documents and field ways.

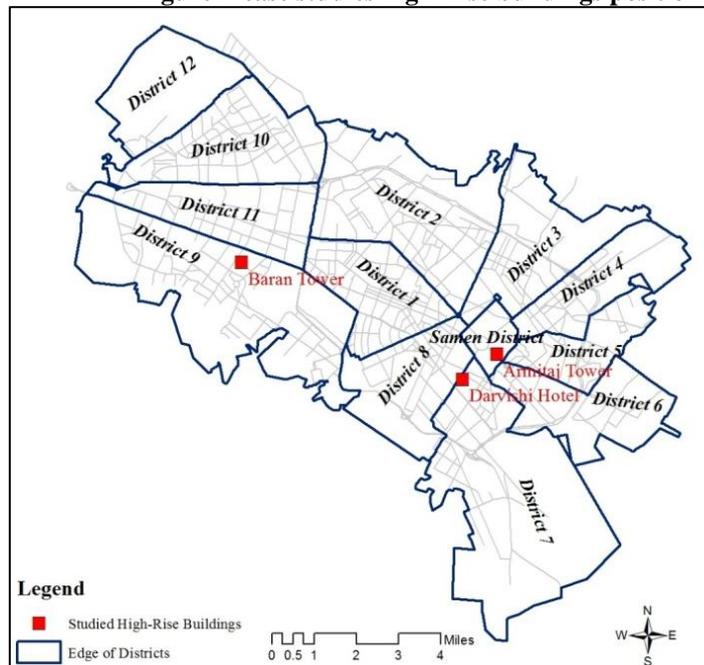
The presented data in this paper relate to all towers of Mashhad metropolitan and the case studies are three famous and important towers of Baran, Armitaj and Darvishi Hotel ,from 40 towers of Mashhad metropolitan (Mashhad Municipality ,2013) which are exploited after 2011 (figure 1). The following table shows the status of the towers. Finally the status of HQE as the international sustainable standards and eco city theory will be determined.

Table2- Towers Status of the Research

Tower Name	Armitaj	Baran	Darvishi Hotel
Land Area	2600	1500	3000
Total Area of Infrastructure	18000	16000	31000
Number of Floors	13	18	22
Exploited Year	2013	2011	2011
Number of Residential Units	100	38	280
Land Use	Commercial-Official Recreational	Residential	Hotel

Source: Authors

Figure1- case studies high- rise buildings position



Source: Authors

3. Discussion and Results

Although the basic idea of studied buildings isn't ecological, and they were designed only with residential, commercial or hotel land uses, but in this article aimed to change the attitude to ecological perspective. So comparing the current situation of ecological indicators and express the distance from these indexes, can provide a plan to improve the quality of future high- rise building.

It should be noted that the numbers specified in Table 3 shows the adaptation of studied buildings with the criteria of ecological design. The numbers have been achieved through a detailed questionnaire and interviews with managers, residents as consumers and design engineers group as creators of the towers.

After classification of both the external and internal environment in four groups, the status of the towers are as shown in table 3. This table indicates that almost none of the towers have considered the green architecture principles. The result shows that Armitaj tower achieves 2.23 in "ecological construction" groups and the score of this tower is 2.06, 3.5 and 3.41 in three other target groups respectively. Baran tower as the second high rise building which has been investigated in this paper, achieves 2.02 in the first target group and has 2.66, 3.35 and 3.5 points in three other groups. Finally, Darvishi Hotel as the last tower in this article, receives 1.94, 2.21, 2.7 and 3.58 in the all four target groups respectively. (The numbers are from 4 points).

So the results indicate that few cases of HQE parameters are implemented in the Towers that are not for the ecological thinking but for providing welfare in order to distinguish it from

other buildings and make more expensive per square meter buildings for sale. So the hypothesis of the research confirmed which that is no possibility of ecological thinking and green architecture building in Mashhad high-rise towers.

Table 3- Quantifying the indicators to assess the high buildings in terms of sustainability

No.	Main Groups	Target Groups	Armitaj		Baran		Darvishi Hotel	
1	External Environment	ecological construction	2	2.23	1.7	2.02	1.5	1.94
2			0.7		0.3		0.33	
3			4		4		4	
4		ecological management	2.7	2.06	3.7	2.66	3.75	2.21
5			5		1.3		1.3	
6			0		3		1.5	
7			3.5		2.6		2.3	
8	Internal Environment	Comfort	4	3.5	2.6	3.35	1.3	2.7
9			3.5		3.5		3.5	
10			3		3.3		3	
11			3.5		4		3	
12		Health	3.2	3.41	3.5	3.5	3.75	3.58
13			5		3.5		3.5	
14	3.5		3.5		3.5			

Source: Authors

3.1. Survey the ecological indicators in case study high-rise buildings

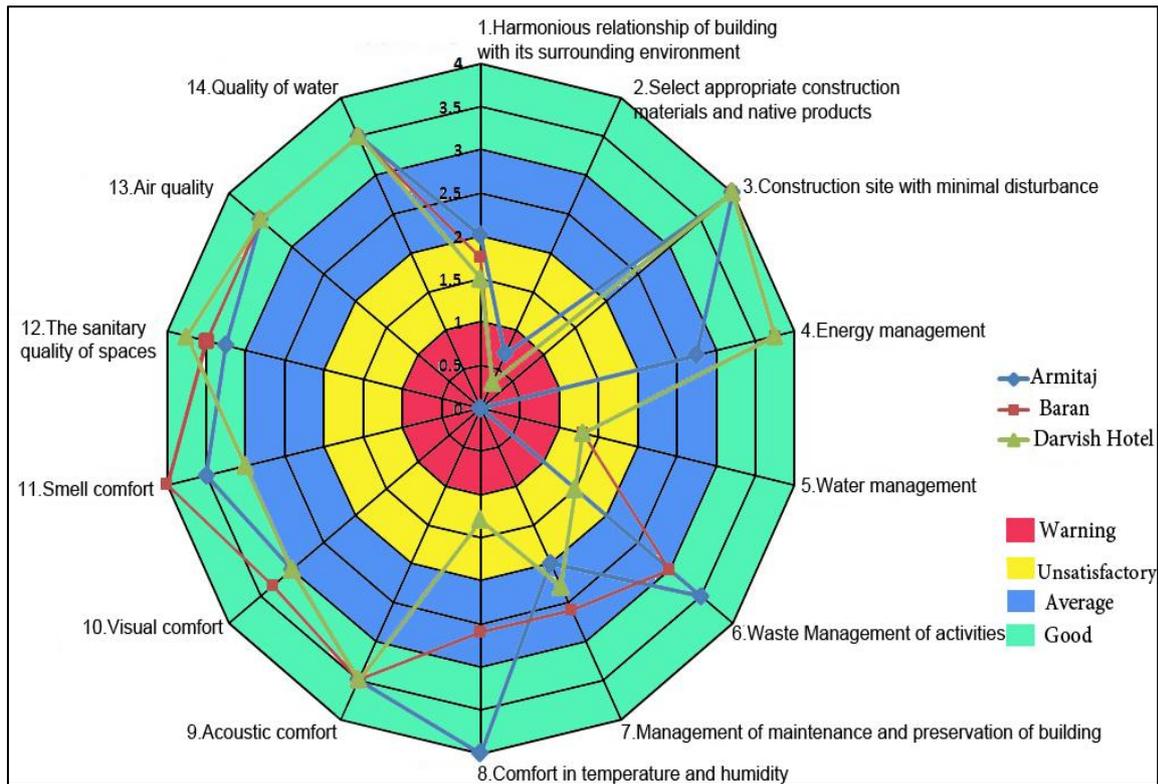
Figure 2 shows that all three towers on second secondary target of "Select appropriate construction materials and native products" are in warning status (Score between zero and 1), which indicates that the materials are non-recyclable and non-native.

According to the director of the towers, about 38% of the towers materials are native and other materials are imported from other cities or other countries. "Water Management" as Goal number five, with indicators such as rainwater recycling and separation of treated and untreated water for irrigation, washing cars, etc., is in warning status in the first tower (Armitaj Tower) and is in unsatisfactory status in two other towers (Score between 1 to 2). Water management is one of the most important issues in city of Mashhad where the shortage of water resources is one of the severe environmental crises.

Taking the advantages of solar energy, greenness coordination with the local climate and proportionality form of building with compact or open texture as indexes of goal number one of " Harmonious relationship of building with its surrounding environment " in all three towers is in undesirable situation and the scores are between 1 to 2 points. Goal number six "Waste Management of activities" in tower no.3 (Darvishi Hotel) and goal number seven "Management of maintenance and preservation of building " in Tower no.1 (Armitaj Tower) earns from 1 to 2 points which indicate the unfavorable situation in these indicators.

So we can say that only the targets related to health are in good shape in all three towers (Score between 3 and 4), but three other target groups have such a different status in all studied towers.

Figure2- Assessment diagram of criteria in fourteen goals



Source: Authors

4. Conclusion and Recommendations

The results indicate that although developed countries insisted on imposing architectural design standards to achieve the objectives of sustainability and green architecture principles and the criteria are used for sustainable design (Duchene-Marullaz, et al., 2001), but in Iran and the city of Mashhad, not only results, but also standards has not been considered.

The research shows that towers in the city of Mashhad have poor ecological operation in various aspects of ecological design and ecological construction in main axes. The criteria of energy supply from renewable sources, waste recycling, water consumption and waste water, the use of local material and management and recycling of rainwater have not been considered and the limited items have non-targeted programs. Pay no attention to ecological principles in the towers not because of lack of financial resources, but because the lack of ecological thinking and lack of knowledge of the principles and the other manufacturers' priorities. It requires management and planning in higher levels of decision-making. Manufactured towers are luxury ones that spend a lot of money to design the interior spaces that shows the lack of investment guide in the field of ecological buildings. It can be said that high-rise buildings not only not self-sufficient in terms of energy consumption, but also so

expensive to lack of new technology in energy saving and have used high rate of water resources and energy consumption.

In addition, occupancy level of the towers shows disregard of manufacturers to advantages of the green surfaces and also represents much more economical benefits to build one square meter construction instead of one square meter green space². (The entire towers have 100% occupancy level).

Thus, ecological thinking should be considered in the planning and designing step of the building which has been led to sustainable building in exploitation phase.

It seems that managers of Mashhad metropolitan should consider the importance of eco-cities, green architecture and ecological buildings before the tower makers. They can gradually encourage the builders through the approved laws and regulations for ecological design. They can execute the ecological regulations through the use of stimulus rules, discounts of construction violations and tax relief. Also further studies seems necessary to take the advantages of international experience in terms of improving local literature in the field of ecological urban planning, green architecture, green building and new wave of high-rise building in Iran. So the main recommendations of this paper are: introduce the importance of green cities and green architecture to city managers and high-rise builders, approve of laws and regulations of green design and execute stimulus rules in green design towers.

² - Based on the high-rise building rules in the city of Mashhad, if the plaque is a high-rise building conditions, the occupancy level will be 40%

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