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Exploration and Verification of Effective Ecological Architectural Components in Multi-Functional Building in Mashhad (Case Example: Shandiz Padidehe)

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Research Article

Abstract

Today's buildings are not built with special plans and rules, but based on limited criteria that can be implemented in almost all regions. In these buildings, the idea of ecological design has been neglected, which will gradually create complex problems in the environment. Considering that multi-purpose buildings as a functional development stimulus project affects all aspects of a neighborhood or district, this research, taking into account the basic concepts in ecological architecture, tries to extract and verify the components of ecological design in the functional buildings of the city. Mashhad especially has the Shandiz collection. It is of a nested application and hybrid type that the data collection tool is designed in a qualitative approach and verified and measured in a quantitative approach. Descriptive statistics are used in the qualitative part and inferential statistics are used in the quantitative part. In the qualitative part, ATLASTI software was used to extract the components from interviews with experts, and in the quantitative part, to examine and analyze the components of ecosystem architecture from the perspective of space users (visitors) from inferential statistics. And JMP software was used. In the next step, correlation is taken between the results obtained from two perspectives. The results of inferential statistics and descriptive statistics were different from each other, and in order to apply the results, inferential statistics should be used. In general, the average correlation coefficient between experts' responses has a higher correlation than that of space users, which points to the lack of knowledge of users regarding ecological design components. Also, the results of the research show from the point of view of designers and experts, the components with the greatest contribution are Functional

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independence of the plan and design from details to patterns with a value of (1.000) and the least related to paying attention to the values of the site in design is with a value of (0.211). From the point of view of Space users, the components with the greatest contribution Equality of human rights and nature and attention to the context of the site with a value of (1.000) and the least related Functional independence of the plan is with a value of (0.331).

Keywords: Ecological Design Component; Ecosystem Architecture; Multifunctional Building; Shandiz Phenomenon

1. Introduction

Paying attention to the ecosystem is primarily seen in the native architecture of every climate, and even this type of view in architecture has been followed and considered in the construction of architecture in the best possible way until about a century ago; But at the same time with the growth of modern architecture in the world, attention to the environment, both culturally and climatically, was forgotten. In fact, "after the energy was supplied at a cheap and reasonable price, what happened in the heating equipment and refrigeration ventilation of the buildings?" It is easy to say that all buildings became dependent on heating, air conditioning and refrigeration systems, making it possible for buildings in the form of unacceptable glass boxes to appear in any climate and located at any latitude without worry. This type of architecture is not even compatible with the climate and was not created according to it" (Nicoletti, 2012: 10).

This is while the ancients used natural energies well to create comfort in their settlements, but with the acquisition of fossil fuels and the emergence of modernity and the trend of conquering nature, a kind of disregard for natural energies took place. Even today, with the occurrence of the energy crisis in the 1970s onwards, it coincided with the support of energy saving management from the point of view of the environment, especially solar energy, which played a special role in the works of professional designers. Also, in addition to the impact of this issue on architectural forms, new systems were also invented to cover buildings (such as semi-transparent coatings that cause shadows and refraction of light) in order to balance energy efficiency (Pourmohammadi, 2012: 117). Paying attention to ecology and ecosystem, which includes a wide range of biological phenomena, opens a new passage for creating responsive architecture. This branch, which has many functions in all fields of architecture, including landscape architecture, urban design, building architecture and technology, can open new and useful ways in responsive architecture. Ecosystem actually includes all biological, geographical, climatic, contextual, and cultural and even human social relations (Sharifi and Azarpira, 2014).

So, if a phenomenon can be accomplished according to these characteristics, the best result will certainly be achieved; whether this phenomenon is architecture or any other human phenomenon. Considering that some of these features are neglected in sustainable architecture, it is necessary to go to a richer branch which is ecosystem and ecological architecture (Torani, 2007). There are various local factors that can be considered in the formation of architecture that fits the human ecosystem and ecosystem. In the review of sustainable architecture and models of lead rating systems, etc., the quality of the environment has been looked at in terms of sustainability (Zanjani, 1992).

But paying attention to mental needs and mental and physical peace was less mentioned, measures should be taken to create a design for better environmental comfort for human life. In addition to paying attention to the relationship between humans and nature, ecological or ecosystem

architecture also pays attention to the human ecosystem and takes into account all human patterns, including poverty, income, happiness, human relationships, etc (Blonder et al., 2020: 1796-1810). As Shaker writes in the article "Urban Ecology and Sustainable Development and Review of Iran and the World's Experiences", the word ecology cannot be understood only in its environmental aspect, ecology shows the social, climatic, cultural conditions and customs of different societies. So that the natives of any place; It carries its own material and spiritual cultural heritage and identity (Shamai and Pourahmad, 2014). This research aims to extract the components of ecological design in ecosystem architecture and tries to answer the question of what are the components of ecological design in ecosystem architecture and which ones have a greater contribution in the multi-functional buildings of Mashhad.

2. Literature Review

In 2019, in an article entitled "Evaluation of ecological architecture affected by the interaction of man-made environment with nature in cold regions, a case example: a historical tavern in Ardabil", Javadi Nodeh et al. Ecological also shows compatibility with the environment, in fact, by using natural resources, they have overcome the effects of cold climate in such a way that the rooms with seasonal function, such as Shahneshin and Sardab, perform optimally against temperature fluctuations.

Mahzoun in 2018 in his thesis entitled "Designing a four-story residential apartment system with an ecological architecture approach in the 11th district of Tehran" examines the knowledge of living beings and their environment and their relationships, and in contrast to sustainable architecture, he looks for solutions in It is against the traditional patterns that can prevent the occurrence of issues such as the destruction of natural resources and the destruction of ecosystems, pollution and global warming. The findings of the thesis indicate that although several factors such as cultural, environmental, economic and social characteristics are influential in the design of a four-story residential apartment system with an ecological architecture approach, compliance with the principles and criteria resulting from fundamental and applied research in the field of architectural design And the design of the site as well as the appropriate structure can consider the use of residential apartments as a desirable, appropriate and realistic solution for housing people and providing other needs related to social and environmental activities, especially in big cities.

In 2017, in his thesis entitled "Designing a commercial-entertainment complex of Qeshm Island with a naturalistic and climate-compatible architectural approach", Zarb Estjabi deals with the design of a commercial-entertainment complex of Qeshm Island with a naturalistic and climate-compatible architectural approach. The current research has been carried out using a descriptive-interpretive method and using qualitative analysis, in which both library and field methods have been used to collect information. The results of the research show that benefiting from the principles and methods of sustainable architecture that emphasizes naturalism and adaptation to the environment's climate in the selection of the site, ideation, design of the interior spaces and the building shell, and the selection of the materials used, in addition to improving the quality of the urban space, leads to Investment attraction and social prosperity will be limited.

In 2016, Arin and Farajpour investigated the characteristics of green roofs, green facades and their environmental functions in Tehran in a theoretical research entitled "The effect of green roofs and green facades on increasing environmental quality and reducing energy consumption in Tehran". The result of this research showed a significant reduction of dust particles suspended in the air (about 20,000 tons) by creating 20% (equivalent to 100 square kilometers) of green space on the roofs and facades of residential buildings in this metropolis, which in turn converted 37,000

tons of carbon dioxide into Oxygen becomes during the day. Also, this research clearly shows that there are very favorable environmental effects, such as: reducing energy consumption, reducing the effect of the city's heat island by cooling the ambient air vapor, reducing the risk of flooding, improving the energy efficiency of buildings, etc. As a result, the use of green roofs and facades in this are a metropolis.

In 2015, in the article "Analysis of Ecological City Indicators in High-Rise Buildings of Mashhad" by comparing the criteria of ecological design in a studied area, Rahnama and Razakian try to clarify the perspective of ecological thinking to some extent in the current situation; Therefore, he evaluated 14 micro-objectives in the form of four groups: "ecological construction", "ecological management", "comfort" and "health", and the final score indicates the ecological status of the building. The findings of the research showed that the principles of ecological design have not been paid attention in almost any of the towers, and few of the HQE standards have been implemented in these towers, not because of the existence of ecological thinking in construction, but because of creating a distinction with other buildings and making each square meter more expensive for the building to be sold.

Ali Haji Qanbari and his colleagues in 2015 in an article entitled "Combination of ecological architecture and new technologies in reducing energy consumption in mountainous areas, a case example: Tabriz metropolis", with the aim of modeling the typical architectural elements of the cold and mountainous climate of Tabriz and combining them with new technologies. As a result, it suggests the use of double-glazed walls instead of thick walls, the use of double-glazed windows instead of regular windows, and other elements included in the article so that energy consumption can be controlled by styling the building.

Kolivand and his colleagues (2014) conducted a research entitled "Investigation of the thermal performance of vegetation in urban open spaces, a case study: Imam Khomeini Port" in an urban area in a hot and humid climate in Imam Khomeini Port. They simulated the area using Envi-met software and examined 12 different influencing factors including: height change, building density, vegetation type, etc. Finally, the results of this research were that as the density and height of buildings increase, the air temperature also increases, which causes an increase in thermal complaints. They also stated that as the area of vegetation increases, the impact also increases because trees create a cooling effect by shading the environment and facilitate the process of thermal comfort compared to grass surfaces.

Syed and Fernandez in 2018 in an article titled "A Reference Architecture for Ecosystem Application with the Purpose of Container Modeling" in UML software to control the ecosystem in heterogeneity and complexities. It was found that the use of Container in the building is abundant.

3. Theoretical Foundation

3.1. Ecological Architecture

Ecological architecture is a trend in the sustainable development of the current world. Architecture based on the principles of ecology is one of the aspects of sustainable architecture. In the 1960s, the Italian-American architect Paolo Soler coined the word "Archeology" from the combination of architecture and ecology (Kenworth, 2006). The first term was known as "ecological architecture". Ecological architecture works on the environment of natural ecology, values natural resources and has a fundamental impact on urban and global ecology (Su et al., 2018: 783-789). In fact, that type of architecture that communicates with nature's ecosystem cycle and

makes maximum use of clean energy by using today's technologies is called ecological architecture (Table 1) (Shamai and Pourahmad, 2014).

Table 1 The term ecology, ecological or biological design and ecological architecture (Source: Madirorusta and Rostami, 2013).

Terms	Topic
Ecology	The combination of the two words house + knowledge Science and knowledge of relationships between organisms with
Ecological or biological design	Integrating artificial biological systems with natural systems Designing a harmless and peaceful artificial environment with the
Ecological architecture	least destructive impact on the environment Working on the natural environment and relating to the ecosystem cycle of nature Valuing natural resources and maximum use of clean energy

Ecological architecture must be formed in accordance with design rules. The idea of ecological architecture is based on the relationship between humans and the environment and nature (Zhong et al., 2018: 562-572). Architecture is created based on the characteristics and patterns of the shape of the land, and paying attention to the native aspects of the place is one of the important issues in ecological design (Sharifi and Azarpira, 2014: 15). Considering the building as part of a larger environment and also as a habitat for organisms is a vital issue in ecological design (Yushanjiang et al., 2021). Another important issue is how to find a solution for the maximum use of renewable energy (Shamai and Pourahmad, 2014). According to Yang, the first step in design is to check the weather conditions of the place to take advantage of the existing potential and use it in passive systems. These factors will have an important impact on the design of plan, section and architectural form (Mohammadpour and Fenderski, 2013). In general, extensive studies have been conducted in the field of rules and points that should be considered in ecological design.

According to Hanover, in ecological architecture, there is coexistence between man and nature (while maintaining health, diversity, sustainability, and support) and in that, attention is paid to mutual relationships (interaction between man and the environment at different scales) (Yushanjiang et al. al., 2021). Respect for the relationship between material and spiritual elements; The consequences of the design are acceptable. Safe elements are left for future generations. The concept of waste and waste materials (through recycling and modification of life cycles, etc.) is removed (Huang et al., 2019: 89-94). Ecological architecture relies on natural energies (Su et al., 2018: 783-789). Understanding the limitations of design (no design lasts forever and no design will solve all problems. Humility to nature as a guide and not a nuisance to be dismissed or controlled) and seeking continuous improvement through sharing is knowledge (McDonough and Braungart, 1992). According to van der Ryn and Kwan, in ecological architecture, solutions are derived from the place and return to the cultural and physical factors of the place. The ecological effects related to the design on the environment are considered; design is done with nature (paying attention to biological processes); each person in turn is a designer (Vander Ryn and Cowan, 1996).

According to Todd et al., in ecological architecture, the living world can be the origin of all designs; Design should follow and obey biological laws and not against them; Equal biological rights should determine the limits of design; The design should reflect bioregional aspects (concurrent attention to the geographical, ecological and cultural dimensions of the place); The use of renewable energy sources must be done; Biological systems must be integrated; Design must complement and evolve with nature; Designs should heal the earth; Design should follow ecological values (Todd et al., 2003: 421-425).

According to McLennan, in ecological architecture, there is respect for the wisdom found in natural systems; Paying attention to people (principle of vitality); to place (principles of ecosystem); to the life cycle (paying attention to future generations); to energy and natural resources (principles of protection of natural resources); and it is done to processes (principle of holistic thinking) (McLennan, 2004). According to Shu-Yang-Friedman-Cat, in ecological architecture, there is a response to the inherent needs of humans. The movement towards sustainability of resources (progress towards a sustainable economy through reliance on renewable resources, recycling and reuse) takes place (Zhong et al., 2018: 562-572). Protection of ecological integrity (preserving the integrity of the structure and function of ecosystems) is established. Following and imitating the existing ecosystems in nature; the debt to the natural environment (ecological economy to reduce environmental damage) is eliminated. The natural habitat is protected. Environmental literacy increases to attract social support, protect resources and protect the natural world (Shu-Yang, Freedman, and Cote, 2004: 98-99).

Holmgren developed design principles for human habitats. His view is mostly used in agricultural systems (Holmgren, 2002). Bergen, Bolton and Fredly identified the first principles of ecological engineering design, which are mentioned in Table 2 (Bergen, Bolton, and Fridley, 2001: 201-204).

Table 2 The views of different people and the studies conducted in the field of ecological design (Source: Madirorusta and Rostami, 2013)

Shu-Yang-Friedman-Cat	McLennan	Todd	Sanborn
•Attention to the inherent needs of humans •Paying attention to the sustainability of resources •Environmental integrity •Imitation of the natural ecosystem •Protection of natural habitats	•Respect for the natural environment •Respect for people •Respect for the ecosystem •Respect for energy and natural resources •Respect for holistic thinking	•Matrix world for all designs •Design aligned with natural laws •Reflecting the surrounding biology • Plan •Use of renewable resources •Design in line with reduction •Poor condition of the planet	•Responsible for the environment •Healthy and reasonable building •Attention to society and culture • Beauty •Economically reasonable •Evolutionary
Bergen	**Holmgren**	**Hanover**	**Van der Rien and Kwan**
Site-specific design Functional independence of the plan Design in line with the maximum use of energy Attention to site values in design	Receiving and storing energy Take advantage of automatic adjustment Use of renewable energy No waste generation Design from details to patterns Composition over segregation Creative design and appropriate responses to the environment	Emphasis on human rights and nature for their coexistence Accepting responsibility for the design result Creating volumes, long term value Eliminating the concept of waste Relying on natural energies Attention to design limitations, attention to the possibility of development	•Solutions come from the ground and the site •Ecological data shapes design •Design goes in harmony with nature •Nature is exposed

According to the viewpoints of different people and the studies conducted in the field of ecological design, it can be concluded that ecological design is based on the integration of perspectives in the field of energy, environment and nature, and what is important in this process is the coexistence of buildings with the environment. Ecological design offers a solution that can be used to design livable spaces in harmony with nature (Jafari Khodavardi, and Yousefi, 2016). There are significant differences between environmental design and ecological design, which are stated in the Table 3.

Considering the differences mentioned between the concepts and principles of environmental design and ecological design, ecological design deals with the issue of environment for the present and the future. This design always believes that the artificial environment should be placed in the context of the surrounding ecosystem (Zhong et al., 2018: 562-572). The principles of ecological design allow architects to design buildings with the least amount of destruction to the environment by considering its principles. Also, the superiority of this type of design over environmental design is considering users' and people's opinions in the design process.

Table 3 Comparison of concepts in environmental design and comprehensive ecological design (source: Jafari Khodavardi and Yousefi, 2016).

Comprehensive ecological design	Environmental design	Concepts in design
•Holism •Environmentalism, altruism, adaptability •People and places •The building interacts with the design. • Interdisciplinary •Egalitarianism, circular communication •Unlimited •Designer and specialist •Open system perspective • Maximum •Design according to the evolutionary process •Shaping the process •The designer as a collaborator and coordinator •Working hypothesis •It is judged by users and the public as well as professional designers. •Popular •The designer helps the users to make decisions.	•Determinism •The only beauty •Form, function, structure, space and materials •Building design is the end point. • Multi String •Hierarchical, linear relationship •Limited •General designer •Closed system perspective • At least •Design according to the problem solving process •Shaping the form •Design as senior and critic •Biased •Judged by professional designers. • Individual •The designer makes decisions for the users.	•Philosophical base •Value orientation •Main design variables •The relationship between the building and the design •Type of design •System and communication •Contribution of other fields •The role of specialties •Design perspective • Creativity •Design problems • Design process •The role of the designer •The role of theory in design •Judgment and arbitration •Designers' point of view •Communication between the designer and the users

What is certain from the theoretical literature of the research is that building construction, like any other construction project, will harm the environment. Ecosystem architecture tries to reduce the harmful biological effects during the life cycle of the building and the importance of the efficiency of heating and cooling systems, the use of alternative sources of energy, choosing the right place for construction sites, the use of local and recyclable materials and materials, energy production on site, collecting surface water and reusing it for gardening and washing purposes, on-site waste management is emphasized. These buildings with ecosystem architecture will have the

minimum amount of interference and destruction on the environment and are a suitable solution for the environmental and energy crises that are leading human environments in the present and future. As a result, it is better to create a culture in this field and use it based on our environmental and cultural dimensions and existing experiences, which not only leads to preservation of the life cycle through native design, but also adds color to the body of cities and comfort in all it created contexts. Let's not forget that designing buildings with ecosystem architecture individually and one by one is good, but it doesn't work. To complete a green process, we need a green city; because nature does not consist of isolated green spots, but rather a wide green cover that should cover the city.

3.2. Multi-Functional Buildings

Single-function buildings and their covered areas are occupied only during part of the day or week and remain empty and unused during other times; but multi-functional or multipurpose buildings gather people at different times, which is a much more useful use of an urban space. The construction of high-rise buildings is justified by following the pattern of intensive growth in cities with mixed use of residential, commercial, office, entertainment, etc. in its different floors (Radhi et al., 2013: 179).

Contemporary cities are dispersed in a very dynamic manner, and the development of modern urban structures has been shaped by efficient space management policies that have emerged in the form of multi-functional buildings. In this way, the use of dense spaces has become a feature of new urban spaces. New buildings are built larger and with more diverse functions in order to meet the needs of numerous users in one volume. Multi-functional buildings welcome people with different services (Pourmohammadi, 2012).

These buildings have reduced the horizontal expansion in the environment and this has made these buildings become one of the dominant buildings in today's urban planning.

A multi-functional building is usually defined as a design that at least combines the characteristics of 3 types of use; That is, retail, residential and commercial sales have been created; But the definition that is used today for a multi-functional building is a combination of various components and variables that all work together in an effort made by various international institutions, the following definition is published in Multi-functional building is the development of different uses in the same land by integrating a mix of retail, office, residential, hotel, entertainment and other uses (Radhi et al., 2013: 181). The basic principle in this pedestrian planning is to pay attention to the elements related to the environment, life, work and play. In this plan, the maximum use of space and facilities is made. There are two different words in relation to the word user, one is "basic use" which is the most lasting and profitable use in multi-functional buildings, and the other is dominant use, which is the user who occupies the most space in the design. It is the basic use that drives the concept of development, as well as the decisions related to the appropriateness and compatibility of uses in this plan (Gerigk, 2017).

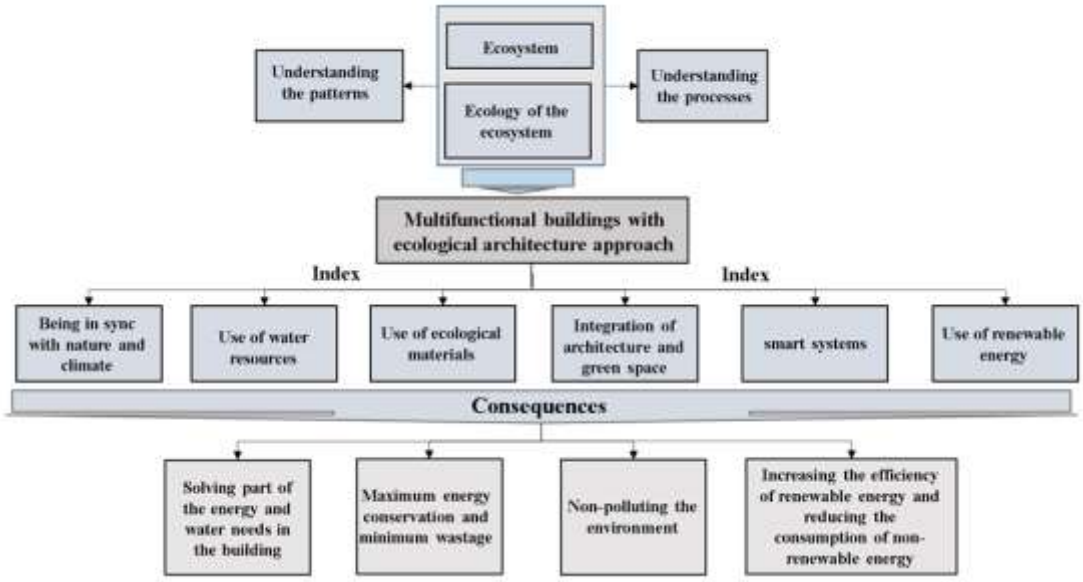

Fig 1 Conceptual model of research

4. Research Method

It is of a nested application and hybrid type that the data collection tool is designed in a qualitative approach and verified and measured in a quantitative approach. Descriptive statistics are used in the qualitative part and inferential statistics are used in the quantitative part.

Descriptive statistics focuses on summarizing the main characteristics of a data set. On the other hand, inferential statistics focuses on making generalizations about a larger population based on a smaller sample of that population. The accuracy of inferential statistics largely depends on the accuracy and precision of large population samples. Doing so involves obtaining a random sample.

In the qualitative part, first, concepts and definitions of ecosystem architecture are extracted and categorized through theoretical foundations. Then, the semi-structured questions of the research interview are designed in accordance with the concepts and definitions taken from the theoretical foundations in the number of seven questions for the interview with the experts. Then, the results of the interview are entered into the Atlasti software and are reduced and extracted the variables of the main theme using descriptive statistics and with the approach of description and interpretation. In the descriptive coding stage, the text of the interview was studied in detail and word for word in search of themes related to the research questions, and at every point of the interview where a theme was found, that part of the interview was selected and a descriptive theme was attributed to it. In the same way, the continuation of the interview was carefully studied and the descriptive themes were attributed to its section. Next, the subsequent interviews were coded descriptively. Then, an attempt was made to go beyond the "description" of the interviewee's statements and focus on the interpretation of their meanings, as a result, interpretive coding was used. This was done mainly by combining descriptive codes that seem to have a single meaning. In the current research, in the interpretation coding stage, the descriptive codes produced in the previous stage were integrated or placed under each other through the interpretation of the meanings of the descriptive codes and during their continuous comparison several times, and finally, axial coding was done.

Table 4 An example of coding from the text of interviews with experts

Axial coding	Open coding		(interview text)
	Interpretive coding	Descriptive coding	Propositions
Ecological management	Energy Management	Use of thermal insulation shells Use of renewable energy	Our buildings should use renewable energy to heat their spaces. For example, put solar panels on their roofs. We have to provide the infrastructure for this. Now in other countries they use insulation and smart materials.
	Management Wastes of Activities	Separation of waste	The main concern of architects and even builders should be to consider the environment. It means to pay attention to both the internal environment and the external environment. Chemical waste, for example, should not be mixed with blood waste. As much as the waste in the environment is reduced and local materials are used, the costs will be reduced and the use of resources will be saved.

In the next step, the author visits the multi-functional complex of Mashhad city with a long thinking system according to the main theme of the article. Data reduction is done in both cases. Based on the results of open and axial coding, a questionnaire with a Likert scale is designed and provided to the group of space users (visitors). The results are compared in two groups using Originpro software. The validity of the questionnaire is controlled by the formula CVR=0.74 and the reliability is controlled by Cronbach's alpha at the rate of 0.78. Inferential statistics are used for data analysis. The statistical population is divided into two groups of space users and people with expertise in this field, and the sample size for both is considered to be the upper limit of Morgan's table and 384 people. The criteria for entry and selection of experts for interviews are as follows:

Table 5 Criteria for selecting experts for interview

Snowball selection	Have at least a master's degree
Be a university faculty member.	Architecture, urban planning, planning.
Have an article related to ecological architecture and its affiliates.	Familiarity with the field of research methodology
Architecture, urban planning, planning.	To be able to visit selected multifunctional buildings
Have design experience in multi-functional buildings.	Have sufficient knowledge of ecosystem architecture and ecological design.
Have enough familiarity with ecosystem architecture.	Have at least one article

In this research, after selecting the participants in the research, the steps of doing the work are displayed in the Fig 2.

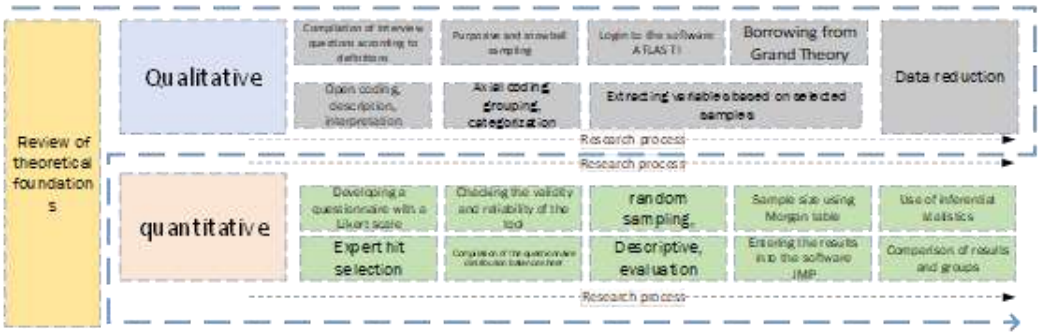

Fig 2 Research process

5. Study Area

Padideh Shandiz multi-purpose tourism complex in Mashhad is considered the largest complex of its kind in the country. This complex includes a shopping center with an area of about 500,000 square meters, a water park, two office towers, a conference hall, residential units under the title of mid-range serviced apartments and a twin tower that includes a 5-star luxury hotel and serviced apartments, the towers with a height of more than 160 meters above the ground, it is the tallest residential building in Iran. Conceptual designs and the first stage of the project have been prepared by ATKINS UK Company, and a significant part of the project's executive plans have been prepared by Atek consulting engineers. Preparation of landscaping plan and interior architecture of the project has been part of Atek's services since the beginning of the first phase.

Padideh Shandiz multi-purpose tourism complex has been designed and implemented on a 50-hectare land with an infrastructure of 1,110,000 square meters in the center of Shandiz city. This complex is projected as the largest shopping, entertainment and leisure center and can be extended to the millions of visitors of Mashhad al-Reza, with a population of over 820,000 citizens, as well as pilgrims to the Holy Shrine of the 8th Imam, whose population will reach 40 million people in the next 15 years. Provide its important, high-quality and memorable services and has the following pillars.

Table 6 Various elements of the city of Padideh

A large cultural complex	Office complex	Flower garden and permanent exhibition of flowers and plants	Indoor playground
Five star hotel	Apartment service complex	Large shopping center	Amusement complex and water park

Due to having various functions and supporting various activities, this complex has many visitors and space users, if ecological elements can be introduced into it, through development stimulating projects, it will play a significant role in preserving the environment and also increasing the mental schema in the audience of these buildings will have.

6. Analysis of Findings

6.1. Descriptive Statistics

In the qualitative part, as mentioned in the research method, semi-structured questions were designed based on the concepts and definitions of ecosystem architecture, and seven questions were designed to interview experts with the aim of extracting components of ecosystem architecture from their point of view. Therefore, first, the experts were asked to start interviewing and answering the questions of semi-open interviews based on observing the documents of Shandiz's multi-functional collection. Then, the texts of the interviews are entered into the ATLASTI software, and according to the categories and themes of ecosystem architecture and ecological design and the interview codebook (balance sheet), the interviews are started to be reduced and live coding, description and interpretation are done in the first stage and open coding of the extracted categories including is below:

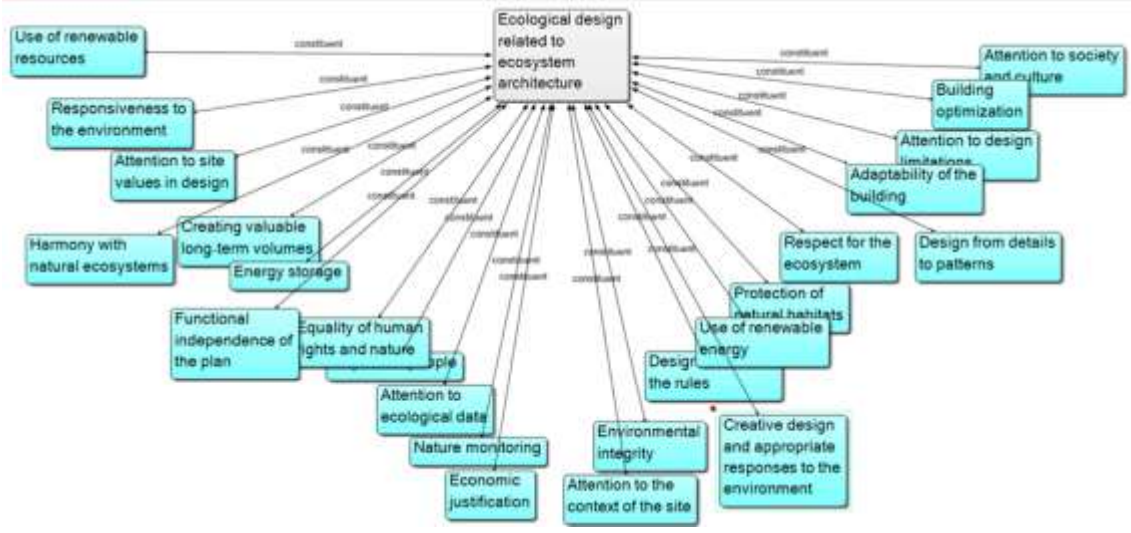

Fig 3 Components extracted from interviews with experts

6.2. Inferential Statistics

According to the descriptive statistics, 253 people (70.7%) of the sample population were men and 131 people (29.3%) were women, and 74.4% were in the age group of 20-30 years. The working method is such that according to the number of components that were extracted from the interviews with experts, the questions of the questionnaire were formulated to be distributed among space users; and each question has an answer between 1 and 5. The sum of the scores of indicators of a component means the score given by each person to the desired quality. Therefore, the score that can be obtained for each quality varies between 5 and 25. Based on this, we create a category in such a way that the people who have given a total score of 5 to 11 to a factor, estimate it poorly, have a score of 12 to 18 as an average opinion and 19 to 25 as a good opinion. The number of experts is 20, which is multiplied by 19.2 to equalize the results. The results of descriptive statistics showed that the most frequency of data obtained from ecosystem architecture design components in the group of space users is most related to nature monitoring and the least is dedicated to economic justification.

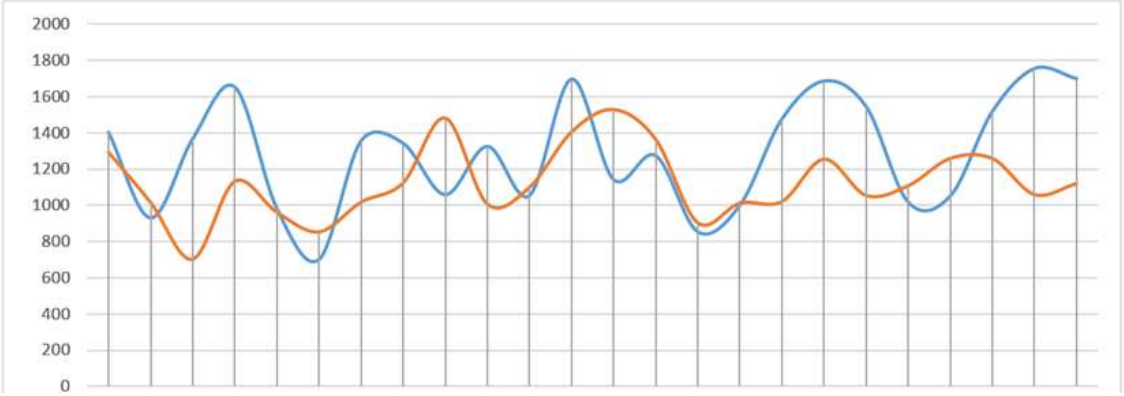

Fig 4 Abundance of ecological design data

6.3. Spearman Correlation

The results of the questionnaire are entered into the Spss25 software after numbering. Predictive relationships (regression) and correlation relationships are used for analysis. Two-Sample Kolmogorov-Smirnov Test is used to check the parametric and non-parametric type of data.

The Kolmogorov-Smirnov test is significant for the score of ecological design components ($p=0.032$) and therefore they do not have a normal distribution and non-parametric analysis should be used for it.

The Table 7 shows the correlation between the variables. As it can be seen, there is a significant positive correlation between ecological design and its components at the level of 0.01. In ecological architecture, from the point of view of spatial users, the highest correlation is functional independence of the plan with a value of (0.991) and the lowest is related to paying attention to site values in design with a value of (0.202). From the point of view of spatial users, the highest correlation is between Protection of natural habitats (0.895) and the lowest correlation is functional independence of the plan (0.409).

Table 7 Correlation between ecological design variables

Variable	Dimensions	Designers and experts		Space users	
		Significance level (sig)	Correlation coefficient	Significance level (sig)	Correlation coefficient
Ecological design	Responsiveness to the environment	0.000	0.743	0.000	0.464
	Attention to society and culture	0.000	0.574	0.000	0.781
	Economic justification	0.000	0.744	0.000	0.645
	Design in line with the rules	0.000	0.739	0.000	0.653
	Building optimization	0.000	0.675	0.000	0.746
	Use of renewable resources	0.000	0.569	0.000	0.473
	Respect for the ecosystem	0.000	0.746	0.000	0.631
	respect for people	0.000	0.807	0.000	0.683
	Environmental integrity	0.000	0.542	0.000	0.473
	Harmony with natural ecosystems	0.000	0.654	0.000	0.623
	Protection of natural habitats	0.000	0.895	0.000	0.895
	Attention to ecological data	0.000	0.889	0.000	0.720
	Nature monitoring	0.000	0.733	0.000	0.425
	Equality of human rights and nature	0.000	0.743	0.000	0.480
	Attention to design limitations	0.000	0.574	0.000	0.415
	Adaptability of the building	0.000	0.744	0.000	0.411
	Creating valuable long-term volumes	0.000	0.739	0.000	0.443
	Energy storage	0.000	0.529	0.000	0.711
	Use of renewable energy	0.000	0.679	0.000	0.562
	Design from details to patterns	0.000	0.628	0.000	0.745
	Creative design and appropriate responses to the environment	0.000	0.542	0.000	0.615
	Attention to the context of the site	0.000	0.574	0.000	0.465
	Functional independence of the plan	0.000	0.991	0.000	0.409
	Attention to site values in design	0.000	0.202	0.000	0.605

6.4. Regression

According to the results obtained from the regression table, it was determined that from the point of view of designers and experts, the components with the greatest contribution are Functional independence of the plan and design from details to patterns with a value of (1.000) and the least related to paying attention to the values of the site in design is with a value of (0.211). From the point of view of Space users, the components with the greatest contribution Equality of human rights and nature and attention to the context of the site with a value of (1.000) and the least related Functional independence of the plan is with a value of (0.331).

Table 8 Multivariate stepwise regression

Scale		Designers and experts				Space users			
		β	B	F	Coefficient of determination	β	B	F	Coefficient of determination
Ecological design	Responsiveness to the environment	0.781	1/000	222/527	0.615	0.741	1/000	314.217	0.867
	Attention to society and culture	0.732	1/000	122/405	0.451	0.429	1/000	523.147	0.895
	Economic justification	0.662	1/000	343/217	0.846	0.587	1/000	578.218	0.769
	Design as per the rules	0.648	1/000	943/199	0.746	0.685	1/000	298.921	0.825
	Building optimization	0.664	1/000	612/201	0.762	0.621	1/000	247.257	0.712
	Use of renewable resources	0.662	1/000	623/643	0.383	0.381	1/000	644.321	0.786
	Respect for the ecosystem	0.652	1/000	683/849	0.753	0.484	1/000	845.523	0.945
	Respect for people	0.681	1/000	654.218	0.735	0.464	1/000	754.254	0.585
	Environmental integrity	0.483	1/000	945/184	0.571	0.421	1/000	124.541	0.965
	Harmony with natural ecosystems	0.464	1/000	748/276	0.770	0.631	1/000	232.241	0.744
	Protect natural habitats	0.452	1/000	943/199	0.795	0.124	1/000	201.321	0.885
	Attention to ecological data	0.463	1/000	034/499	0.893	0.311	1/000	443.124	0.723
	Nature monitoring	0.662	1/000	643/673	0.467	0.325	1/000	229.265	0.358
	Equality to human rights and nature	0.720	1/000	782/489	0.750	0.623	1/000	852.381	1.000
	Attention to design limitations	0.543	1/000	782/489	0.674	0.223	1/000	441.211	0.721
	Building adaptability	0.420	1/000	782/489	0.567	0.529	1/000	321.541	0.946
	Creating valuable long-term volumes	0.663	1/000	412/382	0.752	0.679	1/000	621.991	0.821
	Energy storage	0.410	1/000	782/656	0.732	0.628	1/000	581.920	0.885
	Use renewable energy	0.662	1/000	643/673	0.467	0.542	1/000	218.654	0.675
	Design from details to patterns	0.720	1/000	715/645	1/000	0.574	1/000	752.382	0.756
	Creative design and responses to the environment	0.541	1/000	712/546	0.674	0.456	1/000	514.321	0.561
	Attention to the context of the site	0.394	1/000	732/318	0.567	0.517	1/000	428.167	1.000
	Functional independence of the plan	0.720	1/000	715/645	1/000	0.425	1/000	323.412	0.331
	Attention to site values in design	0.921	1/000	382/752	0.211	0.518	1/000	154.425	0.727

According to the results obtained in the findings section, it was found that the results of inferential statistics and descriptive statistics were different from each other, and to apply the results, inferential statistics should be used. In general, the average correlation coefficient between the answers has a higher correlation than that of spatial users, which affects the knowledge of users compared to Ecological design components mentioned. In the components with the lowest correlation coefficient, its value is close to 0.5, which shows the high correlation between the components and their responses. This is not the case in the factor share and regression, and in general the averages obtained for the two groups are close to each other, considering the physical aspects and paying attention to the people and the needs of different groups in the space as a flexible element over time with more value in ecological design related to architecture. It has been an ecosystem.

7. Conclusion

The principles of ecological design and attention to ecosystem architecture with the use of various components have been considered for many years in the process of designing and implementing various types of buildings with educational, residential, commercial, cultural, etc. uses in developed countries. Multi-functional buildings as a contemporary product have been less investigated in this country. Ecological design can improve the quality of these buildings by preserving various ecosystems. In the Shandiz multi-functional complex, if the ecological design components are verified and implemented and the impact of each component on the ecosystem architecture is taken into account in this research, it can make this complex in line with peaceful coexistence. As a result, to increase the accuracy and accuracy of the data in this research, two perspectives of experts and space users were used.

The results show that the physical and ecological spatial components have been designed more in the multi-functional complex of Shandiz, but less attention has been paid to other aspects such as the environment.

According to the findings of the research, from the point of view of space users, the variables of equality of human rights and nature and attention to the valuable site context had the greatest impact on the ecological architecture of multifunctional buildings in the city of Mashhad. While, according to the experts, the functional independence of the plan and design from details to patterns had the most impact. But the fact is that the use of details increases the waste of materials and consequently reduces attention to ecosystem and ecological architecture.

Some experts mistakenly consider the environment to consist of separate areas of the environment that do not interact with each other. They claim that ecosystems can be sustained by replacing man-made systems. These people hope that technology will allow humans to deal with nature. In fact, experts consider humans to be completely independent of nature.

According to the views of different people and the studies done in the field of ecological design, it can be concluded that ecological design is based on the integration of the views in the field of energy, environment, and engineering, and what is important in this process is the coexistence of buildings with the environment. Ecological design offers a solution that can be used to design livable spaces in harmony with nature.

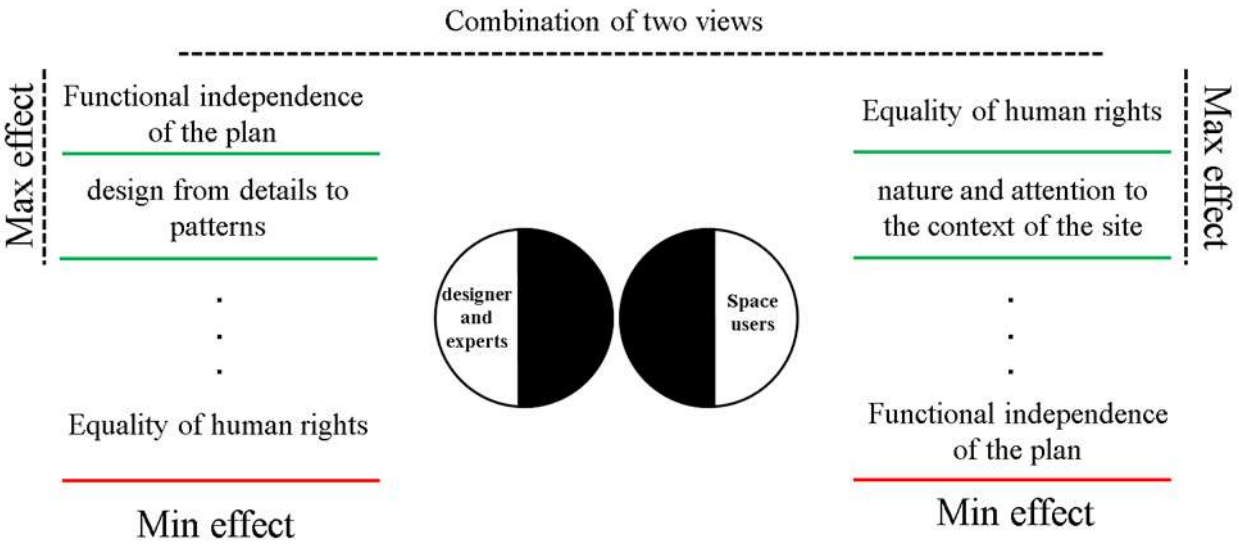

Fig 5 Effect of components from the point of view of space users and specialists and designers

Therefore, the buildings do not have climate function and their shells are the same regardless of their location. In fact, many ecological aspects have not been considered in them. In other words, in this collection, by following the local topography, geographical location, climatic features, the formation of the building form based on cultural, economic and social characteristics, paying attention to the spatial organization based on culture and identity, one of the most optimal responses of the man-made environment in interaction with the natural environment in the complex Shandiz is functional in Mashhad city. The following strategies are suggested to improve the designs of multi-functional complexes as well as complying with ecological design criteria in accordance with ecosystem architecture:

- Paying attention to the ecological data corresponding to each climate in order to recognize and prioritize the ecosystem of each region
- Designing multifunctional spaces for all age groups and dimensional distribution
- Utilizing existing standards such as Bream, Leeds, etc., in order to localize climate and expand environmental sustainability
- Paying attention to the context as the main axis in the internal and external spaces and the connection between them with physical elements
- Utilizing the standards of zero energy buildings in order to store renewable energy and eliminate fossil.

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