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Investigating the Use of Water in the Traditional Architecture of Qajar Period and Determining the Geographic Dispersion in Yazd Province

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ABSTRACT

The objective of the current study is investigating the use of water in the traditional architecture of Qajar Period in Yazd City and the manner of thematic dispersion in the area under study. The research has employed mixed methods (Qualitative and quantitative). In order to identify the aspects of using water in the traditional architecture, the interpretive historical method was employed. The mentioned aspects were prioritized by using Delphi Method (experts' panel) and questionnaires (spectral checklist). Finally, in order to draw the zoning maps, GIS Software, Version 3.3 was used. Results showed that a total of fifteen components were identified in the form of two main aspects (conceptual and physical) as the main components of using water in the traditional architecture in Yazd Province. The component of "hierarchy" with the weight factor of 4.63 and the component of "color" with the weight factor of 4.44 were the most significant ones and the component of "empty space", with the weight factor of 2.41 was recognized as the least significant one. With regards to six aspects of using water, there was no difference among the cities of Yazd Province, and the type of attitude to these components was equal throughout the province to a great extent. With regards to the components of transparency, hierarchy, color, environmental health and nature, some differences were observed throughout the province, in such a way that these components mostly play a role and are significant at the center of the province (Yazd City) and the west side of the province. Yazd province has been very progressive and diverse in the field of water application in architecture, So that all dimensions and functional components of water have been reflected in the architecture of the Qajar period.
Keywords: *Use of water, traditional architecture, geographic dispersion, Yazd City*

1. Introduction

For long, water has had a life-giving virtue in the beliefs of Iranian people and has enjoyed special sanctity and respect [1]. Moreover, one of the most important elements for forming an Iranian house is the element of water. During history, Iranian architects have always used the manifestations of nature, particularly water, in the buildings. Natural elements find order around the main pivots of the building, porches and the passageways, in such a way that the pole, center and heart of the house enclosure are assigned to the water and pool [2]. The water is so important in the construction of the traditional buildings

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composition that it is not possible to deem it separated from the constructed environment, practically, and without water the spaces seem to be lifeless and dry. Iranian houses like any other architectural buildings of Iran enjoy the same feature. Such houses are generally introverted spaces that are full of calmness and life due to the presence of nature. In fact, architects have had a specific emphasis on the nature and its centrality as a sacred phenomenon [3]. Since the valuable buildings remaining from the predecessors' spiritual conduct are the most efficient tool for exploring and reviewing the spiritual and cognitive basics of Iranian-Islamic architecture, whenever any of art and architecture fields of such buildings are reconsidered, the discovery of the concepts latent in their physical form becomes possible [4]. There is a significant relationship among the quality of traditional houses, human beings, architecture and the lifestyle of the past, which emanates from the authentic traditions and values [5]. The components and elements of an Iranian house have also a systematic relationship with each other, in such a way that it might be stated that form, structure, function and the ideologies of that time had a deep relationship with the climatic needs, fabric, and different levels of people's beliefs, and they would reinforce each other in a bilateral relationship [6]. One of the key questions is "What are the different aspects of using water in the traditional architecture of Iran?" On the other hand, it is obvious that this issue is different in the five climates existing in Iran. And, any historical era has had its specific architectural style.

Since a large part of Iran's land is located in a dry and semi-arid climate, and due to the limitations of water resources, the question is always raised, how did the ancients use this limitation as an opportunity? In other words, what are the aspects of water management in traditional Iranian architecture?

In the current research, different aspects of using water in the traditional architecture of Qajar Period in Yazd City and their dispersion throughout the province are investigated.

2. Literature Review

The historical fabric is affected overtly and covertly by the presence and flow of water and the residences are formed near the water flow. An aqueduct is a sample of covert effect of water on forming the residential historical fabric. Also when the running water of aqueduct does not flow from very deep, it comes to the surface and clearly appears in the yard and courtyard of the house in the form of a pool [7]. The Iranian house is formed around an open central space. The house is the center of different human activities which has low communication with the outside and public life. The yard, as an external controlled space, establishes a relationship between the private spaces and the sky, light and air [8]. The historical Iranian house is not separated from nature. Yard of the house is as a room assigned to the presence and emergence of nature, and water is one of the most important natural elements. In the yard of the historical house, water is important for its life-giving and cleaning nature, and the traditional humans have always attempted to supply flowing and pure water in the residential environments. The pools of traditional houses were filled by streams flowing in the passageways. Contrary to the public imaginations, the water was not used for drinking; rather, it was as a water supply for wetting down and removing dust from the yard, porch, etc. [9].

Iranian architects would build some spaces by constructing the water reservoirs, at the beginning, to obviate society's needs and to preserve the importance and value of water, at the same time. The bridges and pools of mosques are two other manifestations of the architectural attention of Iranian people to the element of water. The prevalence of Shiism in Iran and the publicity of mourning for the third Imam of Shiites reinforced the importance of water element in Iran again, from the religious aspect [10]. In the traditional architecture of Iran, the yard is the core, a space with geometric order which is introverted, independent, center-oriented and open to the

sky [11]. The open space of the central yard, with determined dimensions and purposeful orientation and location, is regarded as a key and determinant element for controlling the amount of energy consumption in the traditional houses of Yazd [12]. Generally, the central yard of Iranian houses is one of the successful examples of an architecture which responds to the climate over the world and has been designed based on the precise climatic features, and the cultural and social backgrounds in Iran [13].

The precise and accurate use of contradiction between elements might create a pleasant experience of unity, but the improper and inaccurate use of them might provoke chaos [14]. When the pool is placed at the center of the house, no one is possible to have access to the center of the yard, or in other words, the heart of the house. When the pool is smooth and undisturbed, the reflexivity of water causes the image of the house and sky to be reflected, which serves as a bridge in the house that makes possible the relationship between the ground and sky in the physics of the house [15].

The climatic status of Iran, aridity, and the problems of irrigation and cultivation have caused water and the affairs relevant to that to seem important. In the Iranian rituals, water is considered as one of the sacred elements worthy of worship. Worshiping water has usually been a sign of urgent need of people for water and it indicates the value position of water. From climatic viewpoint, water refreshes the environment. In the climate of arid and semi-arid cities, yards are regarded as the lungs of the city, and the presence of the fountains makes the air to be fresh and cool [4]. From the aspect of architecture and its relation to water, Zoroastrians would purify with water an open sacred space which was in rectangular shape and was called Pavi, after marking four sides of it and reading a certain prayer for the exodus of the soul of demons. Water reflects the image of the building. This is a kind of mirroring, but mirroring the reality to a virtual form [11]. Water has always been a sign of clarity and purity in the Iranian culture [12]. The presence of water in the mansions and gardens of Safavid period was mostly specific to the ponds with different dimensions and shapes, and sometimes with various fountains. Architects of Sasanian period would prefer to construct the palaces in such a way that they could have a well command of the big ponds filled with water of natural streams [17].

Based on the studies conducted and by reviewing the background of the research, it is clear that so far no comprehensive and detailed research has been done on the practical aspects of water in the traditional architecture of Iran, especially in the Qajar period. Most of the previous studies have been about the use of cultural and religious aspects of water, and other applications of this element have not been mentioned.

3. The Area under Study

The area under study is Yazd Province. This province was selected because it has arid and semi-arid climate and it enjoys a variety of houses with traditional architecture (Figure 1). In the typology of residential houses of historical fabric of Yazd, three main types of house might be pointed to: houses having a yard, houses with roofed porches, and house-garden. Based on the aerial map of Yazd city, the houses with a yard are more frequent than the other two types [18]. The historic fabric in the cities of Yazd Province has different applications, with a relatively large area, in such a way that in Yazd City, the residential application, with 66 percent of frequency, is at the top compared to the other applications. However, a large population emigrated from the historic fabric overtime [19]. In recent years, the cities of Yazd Province faced uncontrolled horizontal dispersion in supplying residential units [17]. In the current study, 30 samples of residential historical houses of Yazd Province have been selected as the traditional samples. The selected samples from traditional houses include houses belonging to Qajar Period and all the buildings date back to 1791 to 1925.

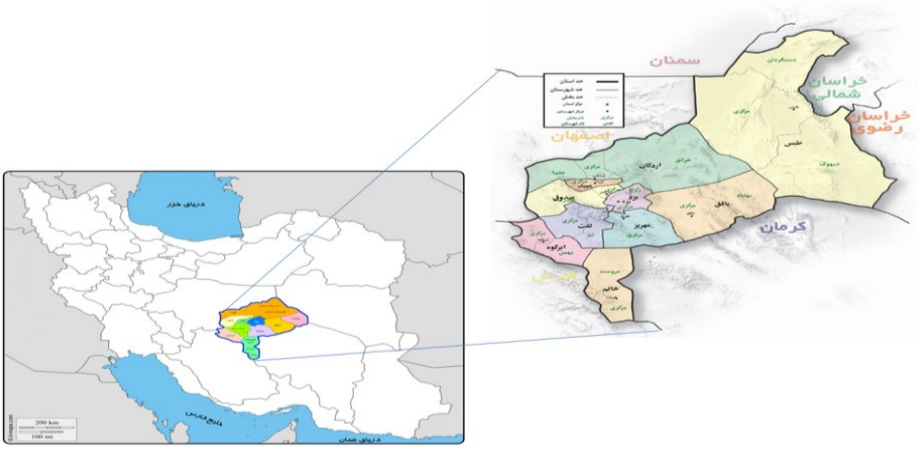

Figure 1. The Location of the Area under Study in the Map of Iran

4. Methodology

The current study is survey- and analytical-based and has employed qualitative and quantitative methods. The meaning of mixed research method is the use of qualitative and quantitative methods consecutively. In this research, in order to extract the components and aspects of water use in the traditional architecture of Iran, a qualitative method has been used. Then, in the quantitative part, qualitative aspects were scored using experts' opinions.

In the first section of the study, to identify the aspects and motivation of using water in the residential and traditional architecture of Iran, the interpretive-historical method was used. In this section, the themes available in myths, popular culture, and Islamic wisdom and also the engineering aspects have been investigated. In the second section, considering the objectives of the study, Yazd Province was considered as the pilot of the study in an arid and semi-arid region. Then, some specific buildings that had certain features of traditional architecture of Qajar Period were selected, and by using Delphi technique (12-person panel of experts) the function of water in each sample was determined. The experts attending the study had the following features:

- Famous architects and university professors who have written valuable works regarding the subject of the study;
- Being adequately aware of the climate of the case study and the traditional architecture of Yazd City;
- Having adequate knowledge and awareness with regards to the selected samples.

In order to determine the normality of variables, the level of significance should be investigated. Kolmogorov-Smirnov Test was used to consider the normality of data. In case the level of significance is lower than 0.05, the variable in not normal and in case it is more than 0.05, the variable is normal. After elaboration on the dimensions and functions of water in each of the selected samples, the aspects extracted from the first section were categorized and prioritized through a questionnaire (weighting checklist). The checklist was designed in the form of a five-point Likert scale, ranging from 1 to 5 (very low to very much). Delphi panel was used considering the design and architecture of each building regarding the valuation of roles and functions of water in each of the selected buildings. The face and content validity were confirmed by the professors and experts, and the total reliability was obtained through Cronbach alpha, which was equal to $\alpha = 0/889$. Finally, the dispersion of dual aspects and fifteen components of the use of water in the architecture of Qajar period in Yazd

Province were investigated by performing an expansive field-based survey. For this purpose, the Geographic Information System, GIS Software, version 3.3 was used.

The steps and steps of the research are as follows:

1. Recognizing the dimensions and reasons for using water in traditional Iranian architecture
2. Selection of study area and pilot research
3. Determining the Delphi panel (research experts)
4. Comparative study of the components of water use in Yazd traditional architecture (study area)
5. Prioritization of extracted components
6. Zoning of water use components in Yazd province

5. Results

The results of the first section of the study indicated that the practical aspects of water in the traditional architecture of the residential fabric in Yazd City, which is located at the arid and semi-arid climate, include two main conceptual and physical factors, each of which has a distinct subset. On the one hand, the conceptual aspect which implies the cultural aspects includes seven components. The components are color, transparency, light, sanctity, art manifestation, nature and prosperity. On the other hand, the physical aspect that implies the engineering aspects includes eight components, namely, geometry and proportions, hierarchy, flexibility, aesthetics, environmental health, creating privacy, empty space and environmental quality. Table 1 shows the main aspects and details of each component.

Table 1. The Aspects and Components of Using Water in the Traditional Architecture of Qajar Period in Yazd City based on the Opinions of Experts (Source: Author, 2022)

Aspects	Components	Interpretation
Conceptual	Color	Beauty and multiplicity
	Transparency	Simplicity and immaculacy
	Light	Transferring boundless feeling
	Sanctity	Pure, holy and the manifestation of Allah
	Art manifestation	Reflective
	Nature	Creator and lifeblood
	Prosperity	Lively and happy
Physical	Geometry and proportions	Equilibrium through locating and designing the elements
	Hierarchy	Creating centrality and diversity in the spatial functions
	Flexibility	Matching the elements of the space with the various functions of the building
	Aesthetics	Illustration and giving a form to the space
	Environmental health	Storing water for daily consumption and obviating the human needs
	Creating privacy	Creating privacy through separating and partitioning the spaces
	Empty space	Introversion through open and closed spaces
	Environmental quality	Creating freshness and joyful feeling through providing moisture and transferring soothing sounds

In the current study, the normal distribution of data was investigated by a test, the results of which are presented in Table 2.

Table 2. Results of Kolmogorov-Smirnov Test for Considering the Normal Distribution of Data (Source: Author, 2022)

Row	Components of the Study	Descriptive Findings			Kolmogorov-Smirnov Test		Results
		Number	Mean	Sd	Statistic Z	Significance level	
1	Conceptual	12	3/11	0/997	2/766	0/001	Non-normal
2	Physical	12	3/79	0967	3/776	0/001	Non-normal

*P<0.05

Table 2 indicates that in all cases, the significance level is lower than the error level of 0.05, the hypothesis of the normality of data is rejected and the data are not distributed normally.

Investigating the samples of the study showed that in all cases under study, the use of water in the traditional architecture has been manifested in the form of fountain, stream, pond step, water reservoir, and pond. It is worthy of note that in some of the samples under study, a combination of the mentioned cases is visible. Since such variables as the little time of atmospheric precipitation, scattered and irregular period of precipitation, low level of precipitation, high evaporation due to the warm weather, low relative humidity of air, low cloudiness, and high percentage of sunny days are known as the characteristics of arid and semi-arid regions, it might be expected that water is considered as an invaluable source for this type of climate and in Yazd Province. Therefore, type of attitude to this valuable source in this region of Iran is different from other regions of the country, such as north of Iran.

Accordingly, the expertise team was asked to determine the share of each of the aspects and components mentioned in Table 1 in the sites under study. The results showed that on the one hand, among the components of conceptual aspect, the highest weight belongs to the component of "color", with the weight of 4.44, and the lowest amount of weight importance belongs to the component of "art manifestation", with the weight of 3.09 (Figure 2).

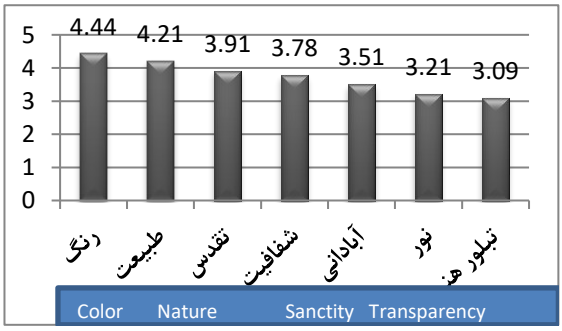

Figure 2. Comparing the Coefficient of Weight Importance of Components of Conceptual Aspect of Using Water in the Residential Architecture of Qajar Period in Yazd Province (Source: Author, 2022)

On the other hand, among the components of physical aspect, the highest weight belongs to the component of "hierarchy", with the weight of 4.63, and the lowest amount of weight importance belongs to the component of "empty space", with the weight of 2.41(Figure 3).

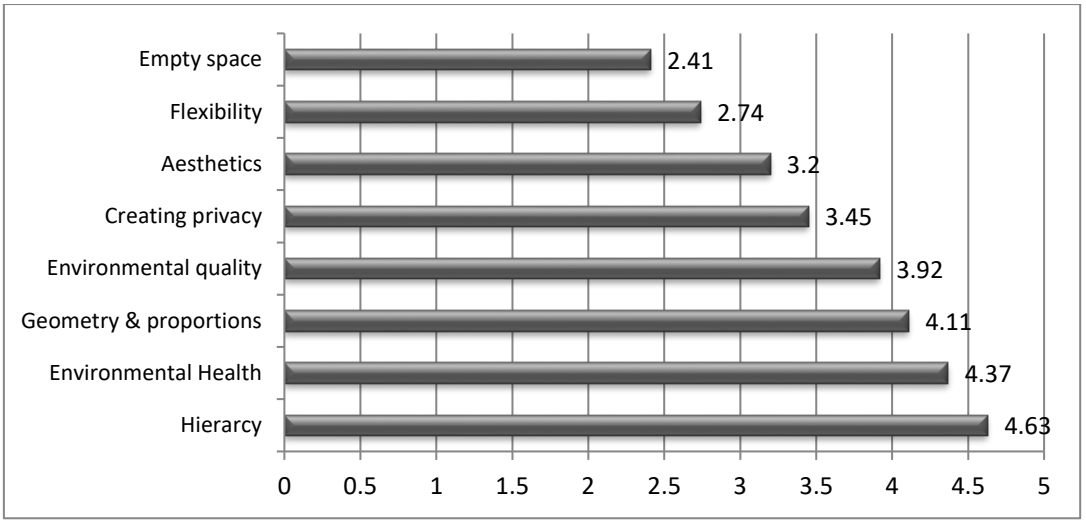

Figure 3. Comparing the Coefficient of Weight Importance of Components of Physical Aspect of Using Water in the Architecture of Qajar Period in Yazd Province (Source: Author, 2022)

According to the mentioned cases, the final prioritizing of the aspects of using water in the residential architecture of Qajar Period in Yazd Province is shown in Table 3, as follows:

Table 3. Comparing the Priority of Aspects of Using Water in the Architecture of Qajar Period in Yazd Province (Source: Author, 2022)

Priority	Aspect	Importance Coefficient
1	Hierarchy	4/63
2	Color	4/44
3	Environmental health	4/37
4	Nature	4/21
5	Geometry and proportions	4/11
6	Environmental quality	3/92
7	Sanctity	3/91
8	Transparency	3/78
9	Prosperity	3/51
10	Creating privacy	3/45
11	Light	3/21
12	Aesthetics	3/2
13	Art manifestation	3/09
14	Flexibility	2/74
15	Empty space	2/41

As seen, the component of "hierarchy", with the weight coefficient of 4.63 and the component of "color", with the weight coefficient of 4.44 have the highest importance, and in practice, they have played a role in the traditional architecture of Yazd Province more than other components of using water.

Considering that the dimensions of water use in the traditional architecture of Iran and especially the study area have been very diverse and numerous, scoring these

components is very helpful to researchers so that they can better recognize the value and contribution of each of the dimensions and components in question. give On the other hand, according to the distribution of settlements in Yazd province and the difference in the type of architecture of each part of this province, based on the findings of the research, it is possible to zone the dimensions of water use according to the geography of the province.

In order to draw the zoning map of aspects of using water in the traditional architecture of Qajar Period in Yazd Province, the cities of the province were investigated. Separated maps for each aspect of using water throughout Yazd Province were prepared and drawn (Figures 4 to 18).

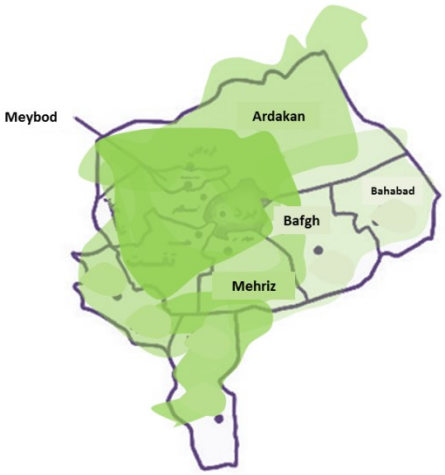

Figure 5. Dispersion Map of the Role of "Color" Component in the Traditional Architecture of Yazd Province

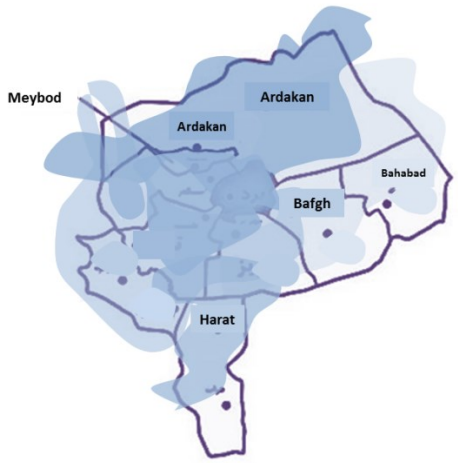

Figure 4. Dispersion Map of the Role of "Hierarchy" Component in the Traditional Architecture of Yazd Province

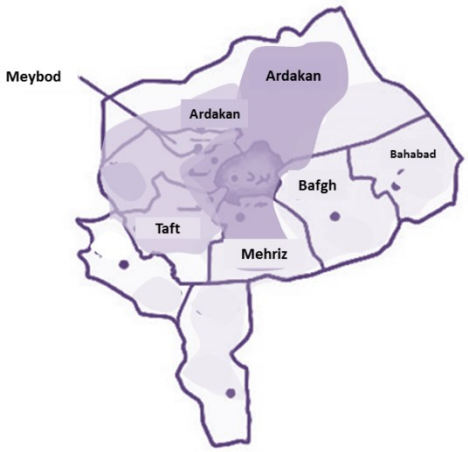

Figure 7. Dispersion Map of the Role of "Nature" Component in the Traditional Architecture of Yazd Province

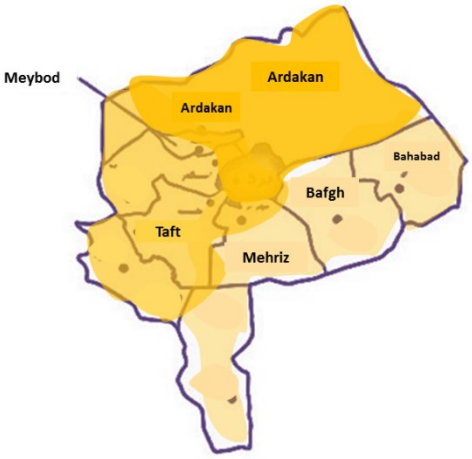

Figure 6. Dispersion Map of the Role of "Environmental Health" Component in the Traditional Architecture of Yazd Province

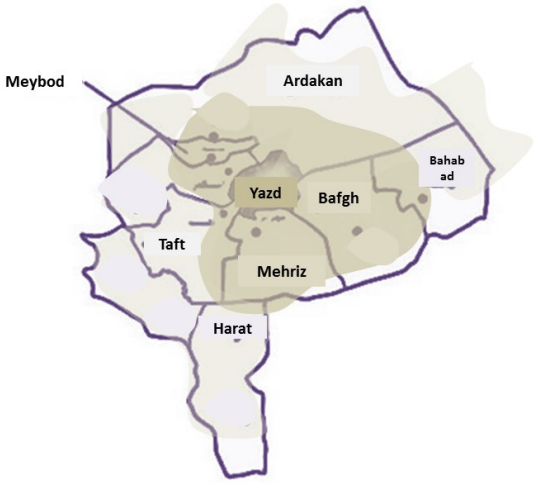

Figure 9. Dispersion Map of the Role of "Environmental Quality" Component in the Traditional Architecture of Yazd Province

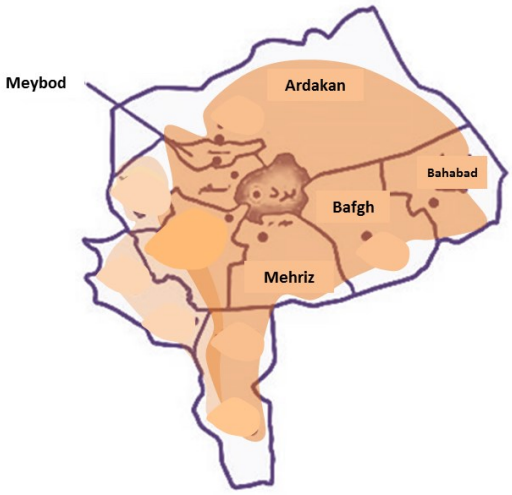

Figure 8. Dispersion Map of the Role of "Geometry and Proportions" Component in the Traditional Architecture of Yazd Province

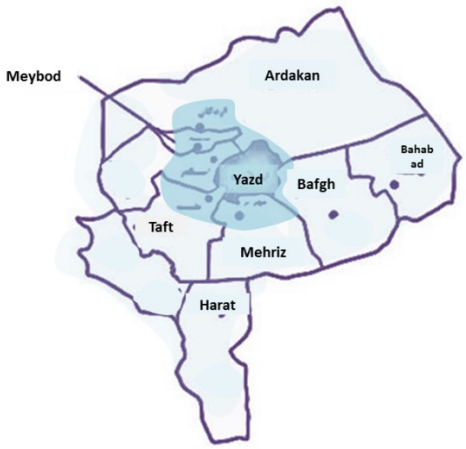

Figure 11. Dispersion Map of the Role of "Transparency" Component in the Traditional Architecture of Yazd Province

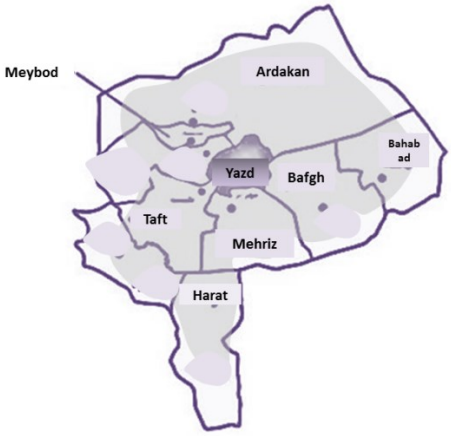

Figure 10. Dispersion Map of the Role of "Sanctity" Component in the Traditional Architecture of Yazd Province

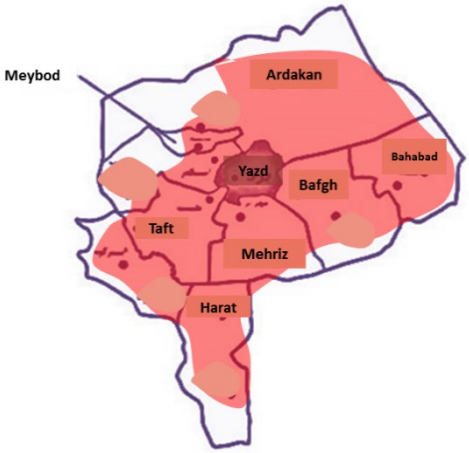

Figure 13. Dispersion Map of the Role of "Creating Privacy" Component in the Traditional Architecture of

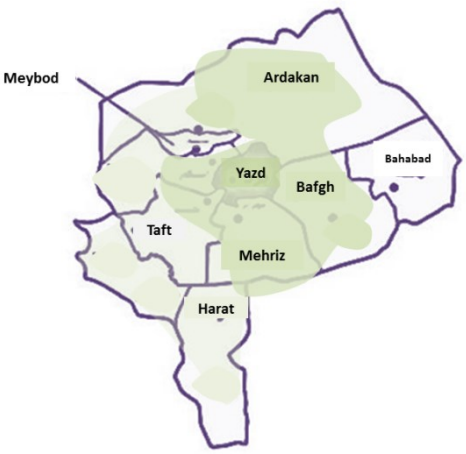

Figure 12. Dispersion Map of the Role of "Prosperity" Component in the Traditional Architecture of Yazd

Yazd Province

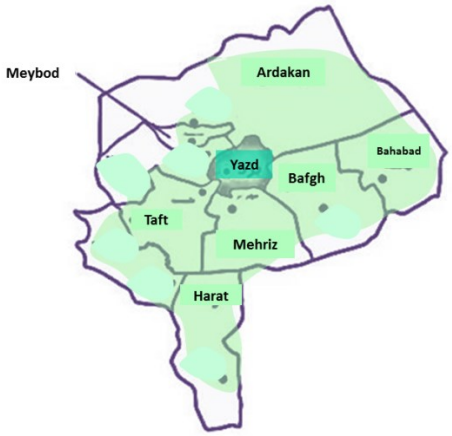

Figure 15. Dispersion Map of the Role of "Aesthetics" Component in the Traditional Architecture of Yazd Province

Province

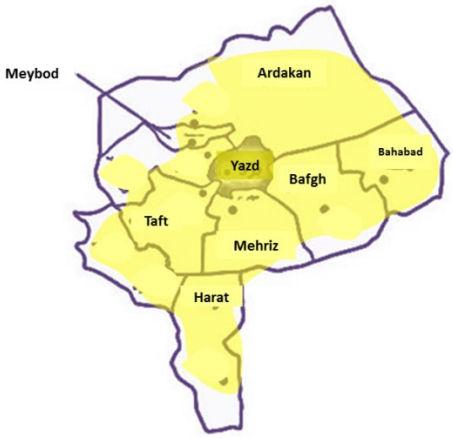

Figure 14. Dispersion Map of the Role of "Light" Component in the Traditional Architecture of Yazd Province

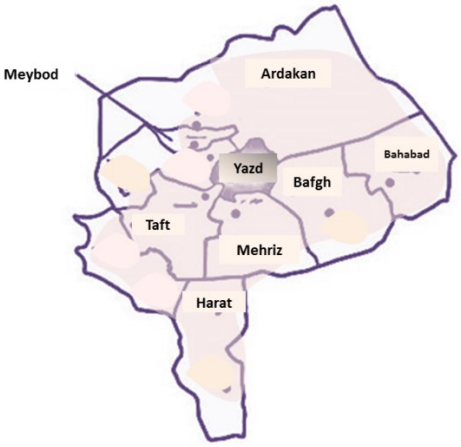

Figure 17. Dispersion Map of the Role of "Flexibility" Component in the Traditional Architecture of Yazd Province

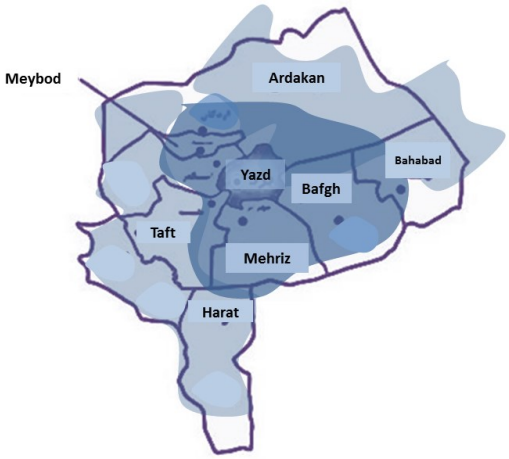

Figure 16. Dispersion Map of the Role of "Art Manifestation" Component in the Traditional Architecture of Yazd Province

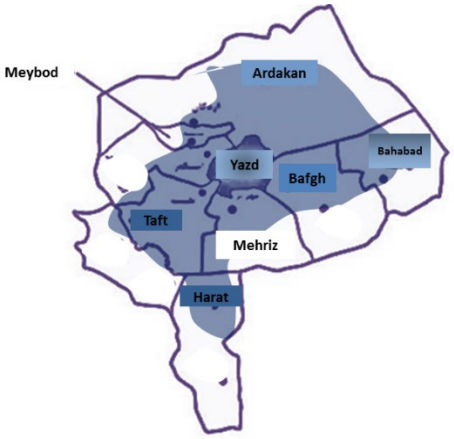

Figure 18. Dispersion Map of the Role of "Empty Space" Component in the Traditional Architecture of Yazd Province

6. Discussion

The purpose of conducting the current study has been investigating and zoning the aspects of using water in the traditional architecture of Yazd Province in Qajar Period. The results showed that a total of 17 components in the form of two main conceptual and physical aspects were obtained as the main and important parts of using water in the residential and traditional architecture of Iran. Among the mentioned components, according to the opinion of the experts of the study and considering the sample buildings, the most important components of conceptual aspect are: color, nature, sanctity, and transparency, all of which having a weight point higher than 4. Moreover, in the physical aspect, such components as hierarchy, environmental health, geometry and proportions were more important and effective than other components.

To interpret the results, it might be stated that the basis of "nature" is based on specific proportions and measurements, and the traditional architect would make his traditional designs by considering the certain order of the nature and cosmology of himself. As stated by Bavandian (2018), in the Iranian traditional housing, the geometric compositions were in such a way that the perception of the meanings of space was possible by the movement of body and eyes. This system was flexible and while having common patterns, it enjoyed a wide variety and was used proportional to the human scale. Similarly, the results of this section match the studies of Toofan (2006) and Bavandian (2018).

The existence of "hierarchy" in the house creates variety in the type of functions, occurrence of activities, view and movement of individuals and caused the entrance, internal, external and service areas to be separated [20]. After analyzing the case studies of the traditional houses, it was determined that in traditional houses, the entrance was always at the corners of the central yard. After reaching the central yard, the person pauses to select his intended space. This issue is in lines with the studies of Sepahvandi (2005) and Naghizadeh (2003). The "privacy" is actually among the hidden aspects of houses, and the contemporary architects are required to identify it in order to provide the divine and spiritual demands of the residents, and in case the identification of spatial privacy is done in the form of an analytical model, the ground for predicting the probable behavior in the intended space of traditional houses and its difference with the contemporary houses shall be provided. This part of the research results is similar to the studies of Shahidi and Bemanian (2009). In the traditional architecture, authenticity is defined by the "empty space" and the place of presence and passage of people, and not a mass, physical form and the building. In the traditional house, space is defined proportional to the internal levels of the forms surrounding it [21]. A yard is a suitable place for the communications of human beings with the natural elements and it is one of the most important factors of the presence of water and pond. The yard is the center and heart of the house, and the existence of central yard in the traditional houses of Iran is a sign of introversion [22].

Since in the arid and semi-arid climate of Iran, the emergence of natural crisis such as drought is more probable, one of the necessary issues considered in the traditional architecture is thinking and designing the methods of water management and storage. The invention of water reservoir and aqueduct is among the solutions for the mentioned issue. Moreover, transferring water to the ponds and the ponds step is regarded as one of the methods of water storage for critical conditions, and the same resources would be used for obviating the routine needs of residents. Such results are in lines with the studies of Darikvand et al. (2022) and Sattary and Zahedian (2015), but they are in contrast with the opinions of Shahidi and Bemanian (2009), because they did not assume that the issue of maintaining and storing water was an important concern for the traditional architects in Iran.

By interpreting the zoning maps, it has been determined that with regards to 6 aspects of using water, there is no difference among the cities of Yazd Province, and type of attitudes to these components is equal throughout the province to a great extent. The components are sanctity, creating privacy, light, aesthetics, flexibility and empty space.

However, with regards to the five other components, some difference might be seen throughout the province, in such a way that the role and importance of such components is mostly seen at the center of the province (Yazd City) and the west of the province. These components are transparency, hierarchy, color, environmental health and nature. Finally, the importance of four other components was manifesting from the center to the east of the province. They are environmental quality, geometry and proportions, prosperity and art manifestation.

7. Conclusion

Since the study area of this research (Yazd province) is located in an arid and semi-arid climate, the traditional architects in this climate had correctly understood that it is necessary to use water for several purposes and reasons. Originally, this important element did not have only one specific use; in a way that includes various conceptual/cultural and physical/engineering dimensions.

Yazd province has been very progressive and diverse in the field of water application in architecture, So that all dimensions and functional components of water have been reflected in the architecture of the Qajar period.

It seems that today it is possible to realize various uses of water through the revision of designs and adaptation of traditional architectural patterns. For example, using water to create a sense of hierarchy as well as reflecting nature in the body of structures.

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