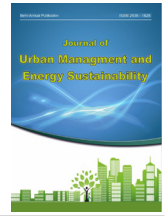


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Green roof patterns to improve the quality of sustainable urban landscape

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ABSTRACT

A landscape is a part of the environment that can be paid attention to in a specific place and related to its context in the environment. The sensitivity of the urban landscape, when it focuses on the concept of sustainability, should be hidden in all the components of the city's body form. The need to study green roofs concerning environmental issues in architecture and urban planning is of special importance to improve the quality of the environment and sustainable urban development. This research has a descriptive-analytical view, which is purposed at development and application. The method of collecting information is the library, First, after analyzing the theoretical foundations as well as the history of the research, factors were extracted as the results of the research framework and presented as the final indicators proposed in the form of a model using the Delphi method. The results of the three rounds of implementing the Delphi method in the research show that a consensus has been reached among the panel members for the following reasons and the repetition of the rounds can be ended. The findings of the indexes to evaluation shows that sense of place, Identity, readability, Proportions, Visual influence, Texture and materials, size, and urban form are the main structure of sustainable urban landscape based on the concept of a green roof investigation.

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1. Introduction

The environment is made from both physical and social aspects. Humans create the places around them and a place independent of humans has no meaning. The relationship between man and place is speculative. People take positive and negative things from the environment or give them back to it (Manso et al., 2021) due to the two-way relationship between the city body and the lives of the users and the direct influence of the two on each other, it is possible to create a space that meets the needs of the users. Such an atmosphere can create dynamism in the city and promote interaction between people in the community. Paying attention to spiritual and psychological needs is next to material needs, which can provide a sense of inner satisfaction in people. The spread of nature-avoidance thinking and indifference towards nature to encourage human society has seriously damaged the quality of human life. Therefore, since the 20th century, the human environment and ecology have taken steps toward the explanation of natural patterns as a recognized science. (Raymond, et al., 2010) But the urban landscape, due to having many elements in it, has made most human minds appear as a representative of civilization when dealing with urban life. In other words, on the one hand, landscape ecology is an essential factor in explaining how nature is present as a qualitative and subjective indicator of the citizen audience and has linearly continued the environment. (Rice et al., 2013) One of the influential principles in the urban landscape is the roof line of architectural buildings, which directly influence the urban landscape. This roofline has a major role in the stabilization of the urban environment, which shows not only the physical form of the environment but also its ecology. (Wilson, 2017) Meanwhile, green roofs, due to their deep background in the architecture of the world, are nowadays among the main components of buildings that are somehow involved in the urban landscape as a determining factor. The landscape of a self-organized city is our passage. A landscape is a part of the environment that can be paid attention to in a specific place and related to its context in the environment (Haris and Trauth, 2020). The landscape comes

from the root of “opinion”, which in Dehkhoda culture means to look at something, to reflect on the future presence of something, insight, thought, and opinion (Finlay et al, 2015). The urban landscape is all the available information from the space that can be received by the senses and processed in the process of perception. information such as form, function, and meaning of space (Bianchini, and Hewge, 2012). One of the main characteristics of the urban landscape concept is that it is presented as an “objective-mental” human-physical” phenomenon and a “social-spatial” structure. The main types of urban landscapes include broad landscapes, inner landscapes, urban scenery, and visual corridors (Arnberger and Eder, 2012). According to Cullen’s definition (1961), the landscape of every city is a response to human behavior, weather conditions, safety factors, and skillful interventions in the framework of increasing the capabilities of the environment (Mostafavi et al, 2010). The urban landscape is the result of the level of contact between a man and the city, and in this regard, the man not only influences the urban landscape through his activities in the structure of the visual landscape of the city but also affects the behavior and mental understanding of citizens through contact with the urban landscape. (Müller et al., 2010) Cullen defines the urban landscape as the art of providing visual and structural integration to the set of buildings, streets, and places that make up the city environment, and considers it the art of how establishing connections between the various components that make up the body of the city (Titova, 1990). Cullen’s view of the urban landscape includes most of the physical dimensions of the urban landscape. His emphasis is more on the visual and objective aspects of the urban landscape. Kevin Lynch considers three factors, perceptual, physical, and functional, to be important in the urban landscape. (Kaplan and Kaplan, 1989) He adds the perceptual aspect to the dimensions of the urban landscape by confirming the grand theories. In “Dictionary of Urban Design Concepts”, Behzadfar places the components of the urban landscape in three parts: physical factors, non-physical factors, and human activities. (Bradley, 2010). He defines landscape as a transmitter that transmits different information

to humans and divides its components into two categories: physical and human. (Wu, 2013) Golkar introduces the landscape as a tangible and tangible part of the form in which the visual, functional, and semantic crystallization of the things that shape the space can be seen. (Wilson, 2004) has also stated that the urban landscape is the citizens' understanding of the city, which takes place through the perception of its symbols (the physical dimensions of the city) and the association of meanings related to them (the mental dimensions and memories). The three objectives of the urban landscape are aesthetic, cultural identity, and functional (Zhang et al., 2013). The goal of aesthetics considers the tangible dimension of the space that creates a pleasant reaction in the user. Paying attention to the physical aspect of the space, the type of volumes and their composition, color, materials, adjacency, dark and light, rhythms, contrasts, milestones and indicators, vegetation, the presence of natural elements, and other characteristics that form tangible dimensions. , is placed in this category. The aesthetics used at this stage is a function of climatic, historical, artistic, religious, traditional, and cultural components. The functional goals of the urban landscape create a context for the design of various topics, which are selected according to the topic of the project and its functions. Goals such as making the environment readable and calming are included in this group. The purpose of the identity aspect of the urban landscape is to create a feeling of happiness, comfort, peace, and security (Zoderer, et al., 2016). The sensitivity of the urban landscape, when it focuses on the concept of sustainability, should be hidden in all the components of the city's body form, one of the main cells of which can be the roofs that somehow contain nature and a corner of the environment.

Landscape ecology and the concept of urban landscape sustainability, as one of the youngest branches in ecology and as an interdisciplinary concept, has presented various theories and protection solutions so far. (Widgren, 2004) This branch of ecology has been expanding rapidly in the world so that nowadays designers and urban planners use it widely for the development of cities. Some studies state that using landscape

ecology and providing green infrastructure and providing ecosystem services in the process of developing cities can be a guarantee for the formation of healthier cities and the emergence of numerous social and economic benefits while increasing the quality of life of citizens. (Tveit, et al., 2006) A city with a sustainable landscape is, in fact, the concept of a city whose base is widely based on vital resources and is formed with environmental considerations in mind. In other words, in the ecological city, all urban structures are planned and designed following the natural conditions of the environment. (Turner, 1989) These cities will generally have four basic characteristics, which include considering the city as a circle and a closed and self-sufficient system, the occurrence of minimal interference and occupation in the natural environment of the bed, and the existence of a maximum variety of uses. and activities and finally creating an optimal balance between the city's population and available resources. (Tilley, 1994) according to the successful experiences that Iranians have had in the past about the appropriate design of cities with their natural environment, or the effective methods used to save resources, such as using aqueducts and windbreaks, or using We have had water and vegetation to soften the air or the way we use eco-materials, are clear examples of the development of sustainable cities, which unfortunately have been neglected and forgotten today. And the methods that are used today for the development and design of cities are just copies of models with misplaced imitations from other regions or countries, without considering the local conditions and characteristics of each region, which today has witnessed its consequences and results. We are the emergence of instability in various dimensions of our urban spaces. (Simpson et al, 2001) On the other hand, according to the "World Environment Commission", sustainable development is a process of change in the use of resources, the direction of investments, the direction of technology development, and an institutional change that meets the needs of the present and The future will be compatible. (Helfand et al., 2006). Sustainable development is a development that meets current needs without compromising the ability of future generations and

answers their needs. Therefore, the ground was laid for planning issues such as sustainable urban landscapes, and the preparations for the design of eco-parks and natural flat and topographical surfaces were entered into the urban planning system. (Zhou et al., 2021) Sustainability refers to the earth's ability to continuously meet the needs of its living inhabitants. (Lin et al., 2018). Sustainable development not only calls for the sustainability of natural resources and the environment but also emphasizes sustainable human well-being and the happiness of residents. (Forman and Deblinger, 2000) Sustainable urban development can be easily achieved at local scales. (Niemela, 2011).

Among the considerations and methods of sustainable urban development is the chain of sustainable natural resources, sustainable protection of urban systems from environmental hazards, and improving the quality of urban life. (Pollalis et al., 2012) The sustainable development of the urban landscape can improve the infrastructure, services, and urban ecosystem to provide sustainable human well-being for its residents. (Research group of sustainable city, 2013) Low-rise buildings with gardens have given their place to multi-story buildings and mushroom-like towers without any appearance of nature, and the surrounding areas need buildings, some use such as roads or parking lots. are assigned On the other hand, in areas with a high degree of density, both in terms of buildings and partly in terms of the volume of traffic, to reduce costs and gain more efficiency in the construction of buildings, a percentage dedicated to green spaces in different ways is added to the total infrastructure. The building is added. (Lynch and Gimblett, 1992). In general, it can be said that human habitation on earth has caused major problems for the environment, such as global warming, reduction of natural resources, heavy rains, air pollution, and destruction of the ozone layer. Sustainable development as the main solution to this problem, just opposite to that, is one of the aspects of the green space strategy. (Steiner and Steiner, 2002). This is while the construction of residential buildings with a green landscape on a large scale seems impossible in many cases due to the rapid development of

big cities. Meanwhile, cities can benefit from the advantages of green roofs both visually and aesthetically and improve the human climate due to the created vacuum. (Stobbelaar and Pedrolí, 2011) The place of urban buildings is considered a middle point of urban green spaces. (CMHC, 2004) A green roof is the use of unused spaces of urban buildings to create green spots. In addition to the aesthetic aspects of the city, this causes air conditioning on the micro-climate scale and reduces air pollution, and ultimately improves the environment of the city's residents. Of course, paying attention to this issue with any approach is not specific to recent decades, therefore it has been considered throughout history. Bam Sabz is one of the new approaches to architecture and urban planning and is based on the concepts of sustainable development, which can be used to increase the green space per capita, improve the quality of the environment, and sustainable urban development. The practical use of roofs can be considered as the possibility of optimal utilization of the urban environment. (Tress et al., 2005) The need to study green roofs concerning environmental issues in architecture and urban planning is of special importance to improve the quality of the environment and sustainable urban development. Based on the policies to reduce the adverse effects of urbanization on the environment, by guiding these activities through raising awareness, it is possible to be effective in improving the environment. Also, the different costs of installing green roofs based on the type, materials, and environment compared to normal roofs, not including green roofs as a part of the sustainable green system, along with other policies of planning and designing urban spaces, the cheapness of energy in Iran and the unwillingness of consumers to reduce energy costs, the lack of a legal framework to encourage investment in this sector, and the lack of informing and informing officials and experts and middle managers of municipalities about the benefits of green roofs. It leads in this direction. When the green roof problem is considered as a small scale, it may not show the macro-necessities, but when the urban landscape as a whole has cells like green roofs, we can understand the necessity of looking at it. (Fig. 1)

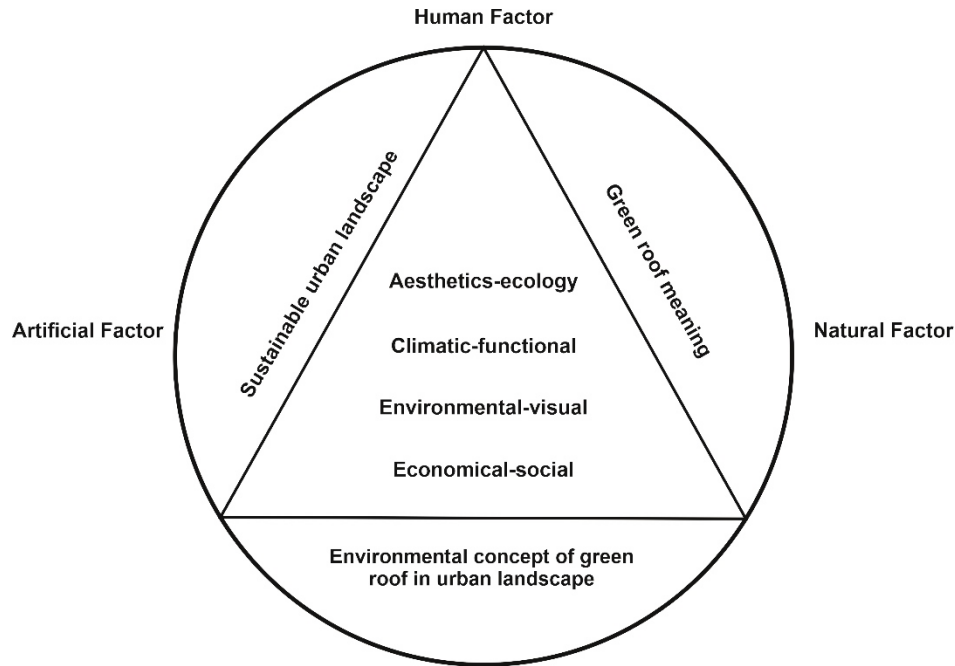


Figure 1: Conceptual model of the relationship between sustainable city landscape and green roof

1.2. Research Background

According to studies on the concept of the sustainable and green urban landscape, the following can be mentioned:

Coma Julia, Pérez Gabriel, Cristian Sol, Castal Albert, Cabeza Luisa, "Thermal evaluation of extensive green roof as a passive energy-saving tool in buildings", *Journal of Science Direct Renewable Energy Articles*, July 27, 2015 : Summary: In this article, two extensive green roof solutions without an insulation layer, the only difference being the drainage layer, materials (one of them with pozzolana and the other with recycled rubber from waste tires) are experimentally evaluated and compared to the performance. The main results of this study are summarized as follows: the two extensive green roofs reduced the electricity accumulation, and the energy consumption was 16.7% and 2.2%, respectively, of the cumulative electrical energy consumed by the conventional roof. flat in periods representative of cooling demand. Therefore, extensive green roofs, especially with rubber crumbs as a drainage layer, can be a good tool to save passive energy

during the summer period in the continental dry Mediterranean climate in periods representative of heating demand. (December and January), the electrical energy consumption of crumb rubber and pozzolana cube increased by 6.1% and 11.1%, respectively, compared to the thermal behavior reference chamber without the use of HVAC, confirming that the thermophysical properties provided by green roofs The studied case does not have enough thermal resistance to cope with the winter. Mediterranean conditions with the current design, the better thermal performance of the green roof with crumb rubber (133.34 kWh) compared to the green roof with pozzolana (142.80 kWh) during the cooling periods, and Uniform heating was confirmed

- Lin Fangzheng, Jinde Ming, Ji Ing Liu, Zhang Linhua, "Simulation Study on Energy Saving Potential of Building Using Green Roof", 10th International Conference on Heating, Ventilation and Air Conditioning, 22 October 2017, School of Thermal Engineering, Shandong University, Jinan, China : Conclusion: The results show that the green roof can reduce the external temperature of the

building and improve the thermal temperature of the building. The environment of the roof and the surrounding environment provide optimization through numerical simulation. Building energy conservation strategies, photosynthesis and shade of green plants reduce radiant heat. At the same time, the green roof plays an important role in protecting the ecological environment and reducing dust and noise (Figures 1, 8, and 9). However, there are still questions such as recycling time for green roofs and air. How does the humidity of green plants affect human comfort?

- Do Vyvedi Aparna, Mohan BK, "Effect of Green Roof on Microtic Environment to Reduce Urban Heat Islands", Applications of Remote Sensing, Society, and Environment, 30 January 2018: Conclusion: This detailed study has proved the existence of urban heat island in the city of Mumbai and applied the quantitative effect of the critical reduction factor of the results, indicating a general approach to the formation of such heat islands in dense urban climate cities in temperate regions, specifically applied to the city of Mumbai. Is. The surface temperature of the earth will be influenced by many factors such as human heat, percentage of city surfaces, land cover, and city layout. The heat island pattern is strongly related to land cover and land use in Mumbai, as well as the amount of vegetation and impervious surfaces determined. Temperature patterns in the city can be seen through remote sensing images. Thermal data obtained from the TM-Landsat sensor and temperature patterns are used to infer micro patterns such as impervious and permeable surfaces around buildings. These temperature patterns also help to draw conclusions about local applications and decide which materials to choose. For example, the glass direction in Mumbai can be used in the north direction because we get diffused light. Due to the presence of sunlight during the day in the southeast and west, the use of glass should be minimized. Such large-scale structures and parks, however, are heat-influencing factors in the city, lakes, and water bodies, which are created by vegetation to create a lower temperature gradient. In Sanjay Gandhi, it is very clear that Po Wai and Wai Har National Park and Lakes are a heat island pattern very closely related to the land cover. (refer to forms 3, 4, 5, 7, 9). This study will

explain the scientific method for urban planners to determine the extent of mandatory greening for a necessary area, which can be adapted for any city. The purpose of this research is to evaluate urban air temperature in residential areas and parks with the help of Envi-Met software. A detailed study of the Persian colony is also considered to understand this issue. Temperature and humidity changes in the area are similar to those studied in the plans with vegetation and without vegetation. Our planners should create a requirement or policy to change land use patterns with more greening. On city levels, all terraces must be required to have a green cover. Vertical walls and the creation of dense vertical urban green cover or forests are recommended. Because the urban heat island effect has been studied for the first time for this region, which is one of the largest.

2. Materials and Methods

First, the effective criteria for the sustainability of the urban landscape are extracted and according to each of the dimensions and structural components, the factors affecting the quality of the green roof are explained with the approach of extracting design strategies. Specifically, based on the four dimensions (ecological, climatic, environmental, and economic-cultural) of the conceptual structure of green roofs, as well as the dimensions of the urban landscape (aesthetic, functional, environmental, and also visual dimensions, taking into account the sense of place), the initial model is proposed. and the effective factors of its linear sharing are determined. In the following, by using the Delphi method and taking into account the concavity of the opinions of the elites and experts, the effective factors have become the initially proposed indicators that are tested and finally, the research framework is extracted. By using the Delphi method and taking into account the concavity of the opinions of the elites and experts, the effective factors have become the primary suggested indicators that are tested, it is necessary to mention that the method is carried out in the form of sending questionnaires and items online, which is done by the researchers. Using survey software, it is done digitally, and finally, the conceptual model (factors) of the research is extracted.

2.1. Delphi Method

The most important task in the Delphi method is the selection of experts and experts in the desired field. In this way, the selected people are given information about the Delphi method and they are invited to participate in this research. Anonymity is one of the important components of this research approach, questions from selected experts are followed by consecutive questionnaires. In this research, first, the initial model is developed based on the theoretical foundations and the use of existing models around the concepts of the urban landscape as well as the structural factors of the green roof. After the initial design, this model was tested and developed through the Delphi method. The use of open-ended questions in the Delphi questionnaire and their analysis in the next stages was a judgment about reaching a consensus among experts and reaching theoretical saturation of the qualitative methods used in the analysis of the data obtained in the present research. The collection of field data in the current research began with the collection of questionnaires in the first stage of the research and the extracted data were analyzed through descriptive statistics and qualitative analysis.

2.2. Delphi method findings

In this research, urban landscape dimensions and green roof components are used as a default in the first stage, extracted from the

theoretical foundations for the subject, and then the landscape dimensions and green roof components are presented according to the research hypothesis. These sub-components have been expressed based on the estimation of the awareness dimension of specialists and also the perceptual process of citizenship with consideration. These factors are set as a package of suggestions in the panel of experts and elites so that the Delphi method can be planned and applied. A total of 12 factors that were tested in this method to reach the final indicators include visual scale factor, visual depth, visual influence, visual clarity, biological comfort, spatial quality, green space, urban form, use, activity, services, stimuli, readability, texture and materials, proportions, size, decorations, biological adjustment, quality of life, vegetation, resilience, identity, sense of place, economy, productivity, consumption cost, mental health, dynamic ecosystem, biodiversity It is a thermal island, microclimate, and air quality.

3. Findings and Discussion

3.1. Findings of implementing the Delphi method

3.1.1. first round

In this round, the panel members identified 12 factors out of 25 factors that were extracted from successful research as having moderate, high, and very high influence in developing a sustainable urban landscape framework based on the green roof concept. The detailed and extended results

Table 1: phase one of the fuzzy method in compiling the final indexes of a sustainable urban landscape based on the concept of a green roof

No	Factors	Number of responses	Average	standard deviation	Min.	Max.
1	Sense of place	15	4/25	0/50	1	5
2	Identity	14	3/39	0/65	2	5
3	Resilience	16	3/15	0/48	2	5
4	Quality of Life	14	3/25	0/68	2	5
5	mental health	15	3/32	0/52	3	5
6	Vegetation	14	3/98	0/29	3	5
7	readability	15	3/75	0/32	2	5
8	Proportions	15	3/32	0/64	2	5
9	Visual influence	15	3/52	0/65	2	5
10	Texture and materials	15	3/45	0/41	1	5
11	Size	15	4/20	0/53	2	5
12	urban form	14	3/87	0/42	2	5

Table 2: phase two of the fuzzy method in compiling the final indexes of a sustainable urban landscape based on the concept of a green roof

No	Factors	Number of responses	Average	standard deviation	Min.	Max.
1	Sense of place	14	4/35	0/40	3	5
2	Identity	15	3/29	0/45	2	5
3	readability	14	3/55	0/22	3	5
4	Proportions	14	3/42	0/44	2	5
5	Visual influence	14	3/42	0/45	3	5
6	Texture and materials	15	3/25	0/31	2	5
7	Size	14	4/30	0/43	3	5
8	urban form	14	3/97	0/32	2	5

Table 3: phase three of the fuzzy method in compiling the final indexes of a sustainable urban landscape based on the concept of a green roof

No	Factors	Number of responses	Average	standard deviation	Min.	Max.
1	Sense of place	15	4/45	0/30	3	5
2	Identity	15	3/39	0/35	3	5
3	readability	15	3/45	0/32	3	5
4	Proportions	15	3/32	0/34	3	5
5	Visual influence	15	3/22	0/35	3	5
6	Texture and materials	15	3/35	0/21	3	5
7	Size	15	4/40	0/33	3	5
8	urban form	15	3/87	0/22	2	5

related to the implementation of the first stage of questionnaire distribution are given in the following table. Factors of visual scale, Visual clarity, Driver, and activity, have been removed from the Delphi process due to their average importance of less than 2.5. (Tab. 1)

3.1.2. second round

After the implementation of the first stage of assessment and evaluation of the opinion of the experts of the panel regarding the factors proposed and extracted from the theoretical bases and also receiving the suggestions of the panel members, in this round, to observe caution, all the factors extracted from the theoretical bases are again Together with the average opinion of the members in the first round and the previous opinion of the same member, it was provided to all the experts of the panel. The

panel members recognized 8 factors out of the 12 factors that were presented in the second round as having a high and very high impact (with an average greater than 2.5) on the research framework. The detailed and extended results related to the implementation of the second stage of questionnaire distribution are given in the following table. Kendall's coordination coefficient for the answers of the members about the order of the 12 factors that had a high and very high influence in this round was 0.725 (Tab. 2)

3.1.3. Third round

In the third round of compiling the research framework, the final indicators, along with the average opinion of the members in the second round and the previous opinion of the same member, were provided to all panel experts. The detailed and extended results related to the

Table 4: A research framework for sustainable urban landscape based on the concept of a green roof

The dimensions and indicators intended to explain the urban landscape quality mechanism based on the green roof concept					
Dimensions	component	Index	Index type	Measurement method	Minimum spatial scale of measurement
Urban landscape	visual-perceptual	Visual influence	Quantitative	Visual preference	Urban Districts
	functional	Urban form	Quantitative	Graphical assessment	Urban Districts
	Aesthetics	Readability	Quantitative	Visual assessment	Urban Districts
		Texture and materials Size Proportions	Quantitative Quantitative Quantitative		
Green roof	socio-economic	Sense of place	Qualitative	questionnaire	Urban Districts

implementation of the third stage of questionnaire distribution are given in the table below. Kendall's correlation coefficient for the members' answers about the order of the 8 factors was 0.780 (Tab 3)

4. Result and Conclusion

The results of the three rounds of implementing the Delphi method in the research show that a consensus has been reached among the panel members for the following reasons and the repetition of the rounds can be ended:

- 1- In the second round, more than 50% of the members chose 12 influential factors in developing a sustainable urban landscape based on the green roof concept, who had an average greater than 2.5 among their factors.
- 2- The standard deviation of the members' answers about the importance of the factors in the third round has changed significantly compared to the previous rounds.
- 3- Kendall's coordination coefficient for members' answers about the order of factors in the third round is 0.725. Considering that the number of panel members was more than 10 people, this amount of Kendall's coefficient is considered quite significant.
- 4- Kendall's coordination coefficient for the arrangement of the 8 influential factors in developing the research framework in the third round compared to the second round only increased by 0.055, which indicates a significant growth in this coefficient or

the degree of consensus among the panel members in two consecutive rounds. does not show

- 5- The points given to the factors by the experts and elites indicate that the characteristic indicators of green roof form, urban form, legibility, and visual scale have the highest score and as a result, the most impact in realizing the construction and working model. Based on this, the following research framework can be presented as the result of studies, theoretical framework, and Delphi method: (Tab. 4)

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