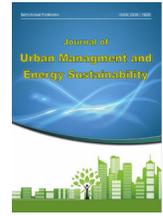


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CASE STUDY RESEARCH PAPER

Explanation of green roof design Indicators in approach to improving urban landscape ecology

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ABSTRACT

Green roofs due to their deep background in the architecture of the world today are among the main components of buildings that are somehow involved in urban landscape as a determining factor. In the current cities, the lack of organizing structure to green roofs has caused a thematic disconnect and a lack of integration, which is one of the reasons for the crisis of urban identity and lack of sense of place in cities is this kind of attitude towards the city. The current research method is analytic research and is aimed at applied and development. He may also be able to look at his discovery. The aim of this study is to explain the proposed indicators for presenting conceptual model and research framework in line with green roof model with the approach of improving urban landscape with ecological vision to the subject, by using Delphi method and considering concave of elite and expert opinions, effective factors have become the primary suggested indicators that have been tested and finally the framework and model of the research have been extracted. The results showed that the effect of greenery index with a score of 0.1456, aesthetic index with a score of 0.1261, paired indices of readability, texture, size and proportions with the score of 0.1195 were more effective respectively and identity with a score of 0.1141 had the least effect.

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INTRODUCTION

The environment is constructed from physical and social aspects simultaneously. Humans create places around them, and places are not independent of humans. The relationship between man and place is a speculative one. People take or return positive and negative things from the environment (Mir karimi et al., 2010). This relationship is mainly based on the interaction of nature and urban context. The development of nature-avoidance and indifference to nature to encourage human society has seriously damaged the quality of human life. Therefore, the environment and human ecology have been recognized as scientific since the 20th century. In fact, it is a natural pattern. (Polat, 2015) But urban landscape, due to its multiple elements, has made most of the human mind as a civilization when dealing with urban life. In other words, landscape ecology on the one hand is a fundamental factor in explaining how nature is present as a qualitative and subjective indicator of the citizen audience and has perpetuated the environment in a linear way. (Sakieh an et al., 2016) One of the most influential principles in urban landscape is the roofing line of architectural buildings that directly affect the urban landscape. This roofing line has a major role in stabilization of urban environment which shows not only the physical form of the environment but also its ecology. (Ode sang et al., 2008) Today, cities have two geographical symbols and the natural, social, economic and artificial environment (man-made environment of riddles). Nowadays, human beings are seeking daily activities and in the process of living and living and in the direction of building housing, whether as shelter or investment capital, has changed these two symbols more frequently Changing the urban environment in this process, green spaces, gardens and forests become high-rise buildings, and with the advancement of technology and industry, the pattern of life has changed and the need for exploitation of natural resources has increased. In a way that irrational exploitation

of natural resources leads to their destruction. (Moghaddasi and Haghghat bin, 2015) Green roofs are in the planning of most advanced cities of the world due to improvement in social, economic and environmental conditions, while even in the 19th issue of the National Building and Housing Regulations on energy consumption has not been mentioned. In buildings, heat dissipation through roofs is usually used It is very high and the energy consumption of the units on the top floor increases, so providing a green roof design pattern is the solution to this problem. (Khakzand et al, 2014)

In the meantime, green roofs due to the deep background in the architecture of the world today are among the main components of buildings that are somehow involved in urban landscape as a determining factor. A city that is self-organized. Landscape is the part of the environment that can be noticed in a particular place and connected to its bed in the environment (Yilmaz, 2007). The perspective is from the root of "Nazare" that in Dehkoda's culture, it means looking at something to reflect on the presence of something, insight, thought and opinion (Rezazadeh, 2007). Urban landscape is all information available from space that can be perceived by the senses and processed in the process of perception. Information's such as form, function and meaning of space (Matlock, 2015). One of the main features of urban landscape concept is that it is considered as an "objective-minded" human-physical phenomenon and a "social-spatial" structure. The main types of urban landscape include extensive landscape, inner landscape, urban landscape and visual corridors (Golkar, 2006). According to Cullen (1961), the landscape of each city is a response to human behaviors, climate, safety factors and skilled interventions in the framework of increasing the capabilities of the environment (Hemmati & Sabounchi, 2021). Urban landscape is the result of human-city contact and, in this regard, man not only influences the structure of the city's visual landscape through his activities,

but also the behavior and mental perception of citizens through contact with the urban landscape. He accepts. (Antrop, 2005) Cullen defines the urban landscape as the art of integrating visually and constructively into the set of buildings, streets and places that make up the urban environment, and considers it the art of how to communicate between different components of the city body (Bell, 2001). Cullen's view of the urban perspective includes most of the physical dimensions of the urban landscape. It is more of a sight and sight to the city. Kevin Lynch considers three perceptual, physical, functional factors important in the urban landscape. (Cassatella, 2011) Confirming Cullen's theories, he adds the perceptual aspect to the urban landscape. Behzadfar in the dictionary of urban design concepts puts the components of urban landscape into three parts: physical, non-physical and human activities. (Eiter, 2010). It defines the landscape as a transmitter that transmits different information to humans and divides its components into two categories: physical-physical and human. (Pakzad, 2006) Golkar describes the landscape as a tangible and tangible part of the form in which the visual, functional and semantic crystallization of the things that make up space. (Golkar, 2006) It is also stated that the urban landscape is the understanding of the city by the perception of its symbols (physical dimensions of the city) and the association of their associated meanings (mental and memory dimensions).

At present, existing green roofs in the country are in practice due to the existence of research gaps and lack of design pattern and the following main reasons:

Lack of attention to the qualitative dimensions of urban environment in the country's urban planning system

lack of adequate water resources, materials (suitable soils)

Lack of proper use of gray sewage, flood control and runoff and proper management of rainwater,

lack of coordination of type and vegetation proportional to the climate of the region and how to cultivate and maintain them

creating and imposing extra weight on roofs and structures

Cost of current methods and lack of complete and professional systems for maintenance

not only have not been useful and responsive and cause the benefits of its positive and effective aspects have not been achieved, but the destructive effects and consequences and negative aspects of it have been more visible in the implemented samples in the country to the extent that the implementation of green roofs in most of the country's buildings has been neglected. Therefore, in metropolises and large cities, contemporary urban landscapes due to the influence of different factors on the formation of their texture and the speed of its changes, on the other hand, the repetition of similar urban landscapes does not represent the characteristics of natural, cultural and historical background. (Jahanbakhsh, 2022) Obviously, green roofs of architectural buildings on intermediate scales can also help to better understand audiences from the urban perspective. In the current cities of the country, the lack of organizing structure to green roofs has caused a thematic disconnect and a lack of integration, which has led to poor connectivity of urban landscape, which is one of the reasons for the crisis of urban identity and lack of sense of place in cities is this kind of attitude towards the city. Overview of the above-mentioned cases and an attitude to the current state of green roofs and urban landscape of Iranian cities, one can imagine the critical situation of un-connecting building roofs, which of course this crisis is more evident when large-scale buildings with diverse uses such as roofs of universities, shopping malls, residential and commercial complex and ... They don't really look at this concept. In the same way, the study of green roof's resources and paying attention to the effective components on improving the quality of urban landscape are among the essentials.

Research Background

In reviewing the background of research on the position of sustainable urban landscape architecture in the field of urban green roofs which is discussed in micro-scale architecture, so far, no research has been observed independently to directly examine research methods and approaches comprehensively, and also an accurate method of urban landscape assessment with a sustainable approach in the field of green roofing has not been defined as a comprehensive method. But in the aspect of landscape architecture, urban landscape, and by placing ecology concept as one of the most understandable instances of the city system and green roofs as a phenomenon, a hybrid method for evaluating and achieving research goals can be proposed as a kind of innovation. Also, the development of sustainable urban landscape concepts and green roof in terms of explaining the structural model of the research, which will lead to the formulation of proposed indicators. There is also a new aspect to this research. In addition, establishing a practical and executive relationship between the green roof design pattern and the quality of sustainable urban landscape for the first time in Shiraz metropolis and also providing a green roof design pattern and promoting it in future constructions as an influential principle in the detailed city plan and mental landscape in order to improve the urban environment and improve the quality of urban landscape can be expressed as the innovation of the current research. (Tab. 1)

MATERIALS AND METHODS

The current research is analytic and is aimed at applied and development. He may also be able to look at his discovery. The aim of this study is to explain the proposed indicators for presenting conceptual model and research framework in line with green roof model with the approach of improving urban landscape with ecological vision to the subject. In this research, in order to achieve basic definitions and theoretical approaches in the field of urban landscape, sustainable urban landscape, green roof and its struc-

ture, the information obtained from reviewing texts, library documents and Internet resources is discussed. First, effective criteria in sustainability of urban landscape are extracted and considering each of the dimensions and structural components, factors affecting the quality of green roofs are explained by the approach of extracting design strategies. Specifically, based on four dimensions (ecological, climatological, environmental, and economic-cultural), the conceptual structure of green roofs as well as the dimensions of urban landscape (aesthetic, functional, environmental and also visual, taking into account sense of place), the initial model is proposed and the effective factors of its linear sharing are determined. Afterwards, using the Delphi method and considering concave of the theories of elites and experts, the effective factors become the initial proposed indicators that are tested and finally the framework and model of the research are extracted.

Literature Review

Implementation of green roofs due to existing research gaps and lack of attention to sustainable architectural principles, lack of suitable substrate such as water supply, lack of proper management of runoff and rainwater, lack of familiarity of employers with a variety of advantages including long-term energy savings and how to easily implement them, vertical growth of metropolises, low per capita green spaces due to international standards and inappropriate distribution in the neighborhood and lack of sub-sub Necessary constructions and legal facilities have led to the creation of an unsustainable urban landscape. With this attitude and the necessity of reducing problems, creating green buildings and benefiting from sustainable architecture regulations will become more and more important considering the current environmental problems. Also, in today's world, sustainable and organic architecture is considered as one of the most important and up-to-date topics and the development of green roofs in the contemporary urban planning system of the developed countries of the world has become an executive

Table 1: Research Background

Researchers	Year	Functional Scale			Methodology	Field of Study	Results
		Macro	Middle	Micro			
Steiner	1991	-	*	-	Ecological Design Method	Landscape Architecture and Environmental Design	How to explain the problems and opportunities according to the urban landscape principle, creating a continuous structure in the construction landscape plan
Hersperger	1994	-	*	*	Ecological planning of urban landscape and green architecture planning principles	Landscape Architecture and Urban Design	Explaining the Ecological Ownership Model and Identifying Urban Green Spots in the Field of Architecture and Urban Planning
yang	1995	-	*	*	Urban Landscape Architecture Design	Landscape architecture and urban design	Presenting a method for evaluating the criteria of design ideas and creating sustainable urban landscape design
Diagle	1998	-	*	-	Comprehensive Model of Urban Landscape Ecology	Landscape Architecture and Green Architecture	Presenting an Economic Framework in Developing Urban Ecological Landscape with Regard to Green Architecture
Marcus	1998	-	*	*	Architectural Urban Landscape Design	Landscape Architecture	Explaining the Relationship between Landscape Architecture and Ecological Planning in the Microscale
Mac Harg	1998	-	*	-	Ecology Planning Method	Landscape Architecture and Environmental Design	Reconstruction and Analysis of Urban Landscape Components and Land Use Adaptation Based on Ecological Principles at Intermediate and Micro Scales
Taylor	1998	-	*	*	The Sustainable Urban Landscape Program	Urban Studies	Presentation of Functional Status in Ecological Systems in Relation to Urban Landscape Based on Green Structure Patterns
Akman	2017	-	*	*	Parametric Method	Landscape Architecture and Green Architecture	Explanation of Parametric Method in Evaluating Urbanistic Landscape with Sustainable Urban Landscape Approach
Yanyu et al.	2018	-	*	*	BIM Assessment	Landscape Architecture and Urban Planning	Presentation of Urban Landscape Design Pattern Based on the Intermediate Relationships of Landscape Architecture and Environmental Roofs
Yong	2019	-	*	*	Visual simulation method of urban landscape in the field of ecology, visual preference and landscape evaluation	Urban and Green Landscape Architecture	Presentation of a Structured Assessment Based on Urban Landscape Evaluation
Viavo et al.	2020	-	*	*	Hybrid Multifaceted Method	Landscape Architecture and Urban Design	Presenting an Optimized Architectural Landscape Framework in Relation to Contingency Connectivity

guideline and the study of the effects of green roofs on the Thermal islands, along with other benefits, have shown that green roofs have many advantages compared to conventional roofs such as increasing ecological power and diversity, balancing and reducing temperature and more moderate humidity. Landscape ecology and sustainability concept of urban landscape, as one of the youngest branches in ecology and as an interdisciplinary concept, has presented various theories and conservation strategies so far. (Gerber and Hess., 2017) This field of ecology is expanding rapidly in the world in such a way that today's urban planners and planners use it extensively to develop cities. There are some studies that suggest 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 at the same time increasing the quality of life of citizens. (Relph, 1976) A city with a sustainable landscape is in fact the concept of a city whose context is widely reliant on vital resources and shaped by environmental considerations. In other words, in ecological city, all urban structures adapted to the natural conditions of the environment are planned and designed. (COE, 2008) These cities will generally have four basic characteristics: considering the city as a closed loop and self-sufficient system, the occurrence of minimal exertion and seizure in the natural environment of the bed, the existence of maximum diversity of land uses and activities, and finally creating an optimal balance between the city's population and available resources. (Tudor, 2014) Considering the successful experiences that Iranians have had in the past in relation to the appropriate design of cities with their natural environment or the effective methods we have had to save resources such as using aqueducts and windfarms, or using water and vegetation for styling the air, or how to use canvas materials, are examples of the development of sustainable cities that are Unfortunately, they are now under

neglect and forgetfulness. And the methods used today for the development and design of cities are merely models with misplaced imitations of other regions or countries that have been regardless of the conditions and characteristics of each region, which today we witness its consequences and instability in various dimensions of our urban spaces. (Watmann et al., 2021)

On the other hand, according to the World Commission on the Environment, sustainable development is a process of change in resource utilization, investment direction, technological development orientation, and institutional change that is compatible with present and future needs. (Nijhuis, 2011). Sustainable development is a development that satisfies its current needs without compromising the ability of the next generation to meet its own needs. Therefore, the grounds for the design of sustainable urban landscapes and the preparation for designing ecoparks and planar and topographic surfaces entered the urban planning system. (Nishimura, 2019) Sustainability refers to Earth's ability to continuously meet the needs of its living inhabitants. (Fairclough et al., 2018). Sustainable development not only calls for sustainability of natural resources and the environment, but also emphasizes sustainable human welfare and happiness of residents. (Forster et al., 2012) Sustainable urban development can be easily achieved on a local scale. (Chhetri and Arrowsmith, 2003). Among the considerations and methods of sustainable urban development such as sustainable natural resource chains, sustainable protection of urban systems from environmental hazards, and improvement of urban quality of life. (Zube et al., 1982) Sustainable urban landscape development can, in infrastructure, improve urban services and ecosystems in order to provide sustainable human well-being for its inhabitants. The low-rise buildings along with the garden have been replaced by multi-storey buildings and fungi-like towers without a representation of nature, and convex areas are dedicated, such as roads or

parking lots. On the other hand, in areas with high density, both in terms of construction and volume of traffic, to reduce costs and obtain more space in construction, the percentage allocated to green spaces in different ways is added to the entire building infrastructure.

The necessity of studying green roofs with regard to environmental protection issues in architecture and urbanism is of particular importance in order to improve the quality of the environment and sustainable urban development. Based on the policies of reducing the adverse effects of urbanization on the environment, by guiding these activities through raising awareness, it can be somewhat effective in improving the environmental situation. Also, the different costs of establishing green roofs based on type, materials and environment compared to ordinary roofs, not including green roofs as part of sustainable green system, along with other policies for planning and designing urban

spaces, energy inexpensiveness In Iran, the lack of willingness of consumers to reduce energy carriers costs, lack of legal infrastructure to encourage investment in this sector, and lack of information and informing officials and middle managers of municipalities about the benefits of green roofs leads us to this direction. The green roof problem when examined as a microscale may not manifest great necessities, but when the urban landscape as a whole has cells such as green roofs, it can be understood the necessity of looking at it.

Urban Landscape Ecology

One can say that the integration of landscape ecology and urban ecology led to a new proposition called urban landscape ecology. Cities are spatially extensive and complex adaptive systems, which we call landscapes. Cities are undoubtedly the main future places of human life, so inevitably most landscape ecological studies will be on cities (Bishop et al., 2001).

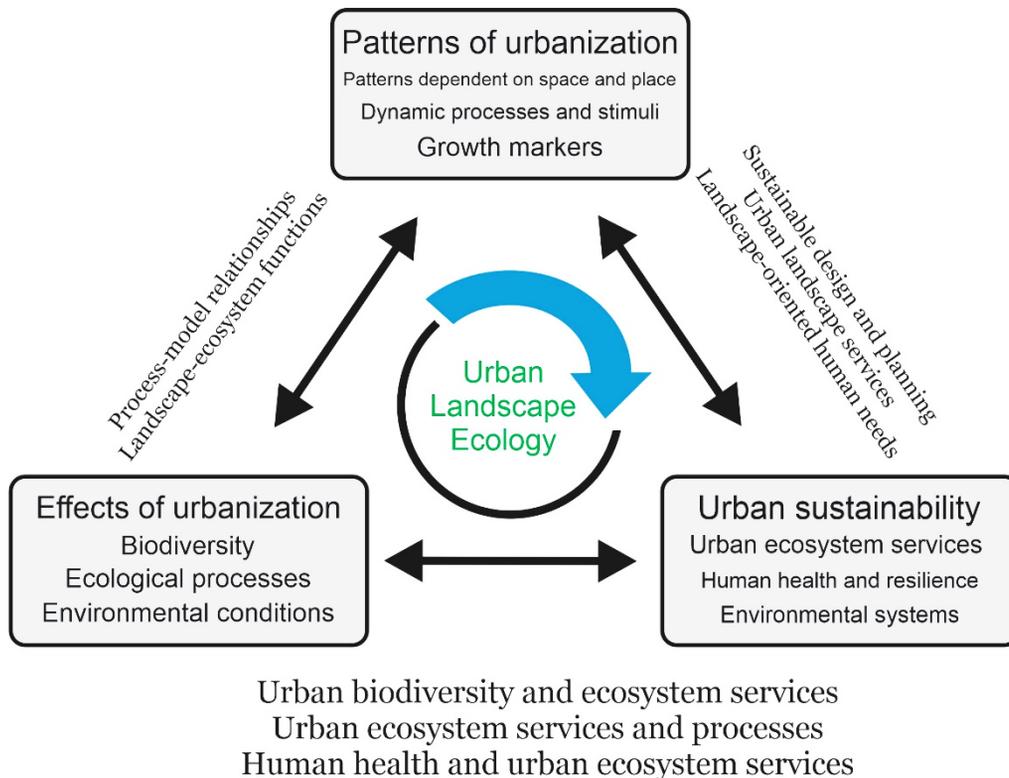


Figure 1: Objective of ecological urban landscape: three elements and their relationships (Wu et al., 2013)

Wu et al. (2013) simply note that the study of landscape ecology of urban areas is identical to the ecology of urban landscape. In particular, the science is the study and improvement of the relationship between urban landscape patterns and ecological processes to achieve urban sustainability. To identify the areas studied in the ecology of the urban landscape, the researchers proposed three key components: Patterns of urbanization, urbanization impacts, urban sustainability (Figure 2). In this regard, Mudrow et al. (2018) examined the literature and related research between 1986 and 2016 to clarify the focus in urban landscape studies, and extracted the most common terms in urban landscape ecology research, including landscape ecology, landscape structure, landscape change, biodiversity, Approaches, gradients, vegetation, GIS and remote sensing. (Figure 1)

Therefore, it can be said that natural and man-made spaces as physical and semantic fabric of cities, human with multiple and hierarchical perceptions and finally the interaction that occurs between human and the environment, causes the city landscape as the first historical, social-cultural, economic and natural manifestation of any city. As can be seen, urban landscape is a multidisciplinary concept that the sciences and disciplines It encompasses a variety of different types. Therefore, based on the mentioned studies on the nature of green roofing funds as part of urban perspective, factors that can affect a direct relationship between both phenomena pass through the course of

evaluating visual characteristics. In such a way that these elements have their own visual nature in the quality of urban landscapes and in addition to their technological nature, only from the visual and perception perspectives Speakers are located. (Figure 2)

DISCUSSION AND FINDINGS

Delphi Method

The most important work in the Delphi method is to select experts and experts in the field of interest. In this way, the selected individuals are given information about the Delphi method and invited to participate in this research. Anonymity is one of the important components of this research approach. Questions from selected experts and experts are followed by consecutive questionnaires. In this research, the initial model is developed based on theoretical foundations and using existing models around urban landscape concepts and also structural factors of green roofing. After the initial design, this model was tested and developed through Delphi method. Using open questions in Delphi questionnaire and analyzing them in later stages, judging about reaching consensus among experts and reaching theoretical saturation from the qualitative methods used in analyzing the data obtained in the present study have been used. Field data collection in the present study began by collecting questionnaires in the first stage of the research and the extracted data were analyzed through descriptive statistics and qualitative analysis.

1. Muderere et al.

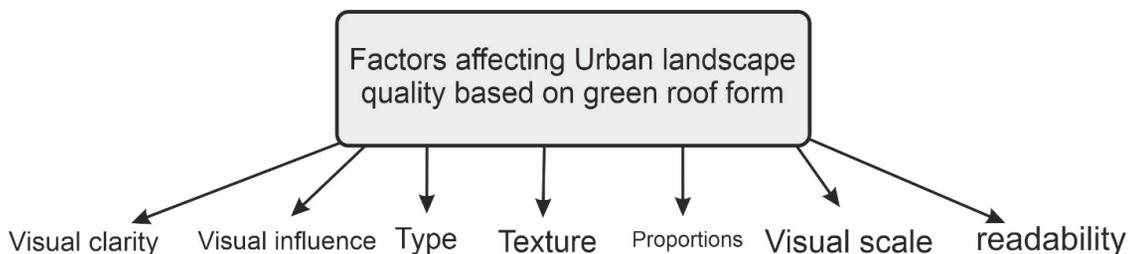


Figure 2: Factors affecting the quality of the urban landscape based on the green roof form

Delphi method findings

In this research, the dimensions of urban landscape and green roof components as the default in the first stage of theoretical foundations for the subject are used, and in the following, the dimensions of landscape and components of green roof are presented according to the research hypothesis. These sub-components have been expressed based on the assumption of the dimensions of the consciousness of the experts and also the perceptual process of citizenship with the inclusion. These factors are set up as a proposed package in the panel of experts and elites to plan and apply Delphi method. The sum of 34 factors that have been tested in this method to achieve the final indices include: visual scale, visual depth, visual penetration, visual clarity, biological comfort, spatial quality, green space, urban form, use, activity, services, stimuli,

readability, texture and materials, proportions, size, decoration, bio adjustment, quality of life, vegetation, resiliency, identity, sense of place, saving, productivity, expenditure, mental health, dynamic ecosystem, biodiversity, thermal island, microclimate And air quality.

Frist Round

In this round, 19 of the 34 factors extracted from the successful studies had a moderate, high and very high effect on the development of sustainable urban landscape framework based on the concept of green roof. Detailed and detailed results related to the implementation of the first stage of the questionnaire distribution are presented in the following table. Resiliency, vegetation, visual influence, activity, stimulus and decoration due to the mean importance less than 2.5 It has been removed from the Delphi process. (Table 2)

Max.	Min.	Deviation indicator	Average	Response	Factors	No
5	1	0/52	4/28	15	Sense of Place	1
5	1	0/63	3/38	15	Identity	2
5	1	0/45	2/11	15	Resilience	3
5	1	0/76	3/21	15	Environmental Comfort	4
5	1	0/51	3/22	15	Mental Health	5
5	1	0/34	1/98	15	Vegetation	6
5	1	0/38	3/72	15	Readability	7
5	1	0/45	3/34	15	Proportions	8
5	1	0/65	1/58	15	Visual Influence	9
5	1	0/48	3/42	15	Texture and Materials	10
5	1	0/53	3/23	15	Size	11
5	1	0/42	3/67	15	Aesthetics	12
5	1	0/24	2/22	15	Activity	13
5	1	0/71	3/20	15	Greenery	14
5	1	0/46	1/20	15	Driver	15
5	1	0/35	3/45	15	Visual Scale	16
5	1	0/54	3/44	15	Visual Clarity	17
5	1	0/34	2/40	15	Decorations	18
5	1	0/42	3/69	15	Formal Feature	19

Table 2: Phase One Fuzzy Method in Developing the Final Indicators of Sustainable Urban Landscape Based on Green Roof Concept

Second Round

After the implementation of the first stage of evaluating and evaluating the views of panel experts on the factors raised and extracted from the theoretical basis and also receiving suggestions of the panel's members, in this round, in order to be cautious, all the factors extracted from the theoretical basis along with the average opinion of the members in the first round and the previous opinion of the same member were made available to all panel experts. The panel members selected 13 of the 19 factors that were completed in the second round. The results of this study were presented with a high and very high effect (mean greater than 2.5) on the research framework. The detailed and detailed results related to the implementation of the second stage of the questionnaire distribution are presented in the table below. Kendall's coefficient of coordination for members' responses to the order of 13 factors that had a high or very high impact in this round was 0.765. (Table 3)

Third Round

In the third round, the final indicators were presented to all panel experts, along with the average of members' opinion in the second round and the previous opinion of the same member.

The detailed and detailed results related to the implementation of the third stage of the questionnaire distribution are presented in the following table. Kendall's coefficient of coordination for the members' responses to the order of the 13 factors was 0.790 (Table 4)

Reasons to stop commenting

The results of the three cycles of Delphi method in the research show that the consensus among the panel members has been reached and the repetition of rounds can be terminated:

In the second round, more than 50% of the members selected 19 factors affecting the development of sustainable urban landscape based on the concept of green roof, which had an average greater than 2.5 among their factors.

The standard deviation of members' responses about the importance of factors in the third round has changed significantly compared to the previous round.

Kendall's coefficient of coordination for members' responses to the order of factors in the third round is 0.790. Given that the number of panel members was more than 10, this amount of Kendall coefficient is quite significant.

Max.	Min.	Deviation indicator	Average	Response	Factors	No
5	2	0/47	4/24	15	Sense of Place	1
5	2	0/71	4/28	15	Identity	2
5	2	0/74	4/11	15	Environmental Comfort	3
5	2	0/55	4/52	15	Mental Health	4
5	2	0/48	4/62	15	Readability	5
5	2	0/55	4/54	15	Proportions	6
5	2	0/58	4/22	15	Texture and Materials	7
5	2	0/41	4/13	15	Size	8
5	2	0/35	4/57	15	Aesthetics	9
5	2	0/76	4/25	15	Greenery	10
5	2	0/65	4/85	15	Visual Scale	11
5	2	0/64	4/61	15	Visual Clarity	12
5	2	0/32	4/79	15	Formal Feature	13

Table 3: Step Two Fuzzy Methods for Developing the Final Indicators of Sustainable Urban Landscape Based on the Green Roof Concept

Max.	Min.	Deviation indicator	Average	Response	Factors	No
5	3	0/67	4/75	15	Sense of Place	1
5	3	0/91	4/61	15	Identity	2
5	3	0/82	4/25	15	Environmental Comfort	3
5	3	0/45	4/25	15	Mental Health	4
5	3	0/38	4/10	15	Readability	5
5	3	0/65	4/20	15	Proportions	6
5	3	0/48	4/05	15	Texture and Materials	7
5	3	0/32	4/13	15	Size	8
5	3	0/24	4/58	15	Aesthetics	9
5	3	0/85	4/95	15	Greenery	10
5	3	0/75	4/30	15	Visual Scale	11
5	3	0/74	4/20	15	Visual Clarity	12
5	3	0/28	4/16	15	Formal Feature	13

Table 4: Step 3 Fuzzy Methods in Developing the Final Indicators of Sustainable Urban Landscape Based on Green Roof Concept

Kendall's coefficient of coordination for the arrangement of 13 factors affecting the development of the research framework in the third round compared to the second round increased only 0.025, which this coefficient or the amount of consensus among panel members between two consecutive rounds does not show significant growth.

Points given to factors by experts and elites indicate that the characteristics of green roof form, urban form, readability and visual scale are the highest scores and consequently the most effective in the realization of the mechanism modeling.

RESULT AND CONCLUSION

According to the results of the evaluation of the final indicators in the case samples for each of the selected buildings, it can be acknowledged that the effect of the Greening Index with a score of 0.1456 was the highest and after that, aesthetic index with a score of 0.1261, paired indicators of readability, texture, size and proportions with a score of 0.1195, mental health index with a score of 0.1184, environmental comfort index with a score of 0.1172, paired indices Scale, visual clarity, and Fermi feature with

a score of 0.1166 and sense of place and identity index with a score of 0.1141 had the least effect. Therefore, the proposed model of research can be based on convergence of researchers' theories and also methods that can investigate the effective nature of green roof in how it affects urban landscape, while the quality of green roof in addition to improving urban environment can contribute to sustainability of urban landscape in the larger and mid-scale. (Tab 5)

REFERENCES

Antrop, M. (2005). Why Landscapes of the Past are Important for the Future. Landscape and Urban Planning, 70(1-2), 21-34.

Bell, S. (2001). Landscape Pattern, Perception and Visualisation in the Visual Management Forests. Landscape and Urban Planning, (54), 201-211.

Bishop, I.D.; Wherrett, J.R. & Miller, D.R. 2001. Assessment of Path Choices on a Country Walk using a Virtual Environment. Landscape and Urban Planning, 52, 227-239.

Bulut, Z., H., Yilmaz .2007. Determination of landscape beauties through visual quality assessment method: a case study for Kemaliye (Erzincan/Turkey). Environment monitoring assessment, 141, 121-129.

Table 5: Research framework of the research

The dimensions, components and indexes in explaining the urban landscape quality mechanism based on the green roof concept					
Minimum spatial scale of measurement	Measurement method	Type	Index	Components	Dimensions
Urban district	Visual preference	Quantitative	Visual scale	Visual-perceptual	Urban landscape
		Quantitative	Visual clarity		
		Quantitative	Formal feature		
Urban district	Questionnaire	Qualitative	greenery	environmental	
urban area	Questionnaire	Qualitative	Aesthetics	functional	
urban area		Qualitative	readability	Aesthetics	
urban area		Qualitative	Texture and materials		
urban area		Qualitative	Size		
urban area	Questionnaire	Qualitative	Proportions		
urban area	Questionnaire H.S.E	Qualitative	Environmental comfort	ecology	Green roof
Urban district	Questionnaire	Qualitative	Sense of place	socio-economic	
		Qualitative	identity		
		Qualitative	mental health	environmental	

Cassatella, C. (2011). *Landscape Indicators: Assessing and Monitoring Landscape Quality*. London: Springer.

Chhetri, P. and Arrowsmith, C. 2003. *Mapping the potential of scenic views for the Grampian National Park*. Proceeding of 21 International Cartographic Conference (ICC). Durban, South Africa. 12p.

COE (Council of Europe). (2008). *Guidelines for the implementation of the European landscape convention*. Achievable: <https://rm.coe.int/16802f80c9>.

Eiter, S. (2010). *Landscape as an Area Perceived through Activity: Implications for Diversity Management and Conservation*. *Landscape Research*, 35(3), 339-359

Fairclough, G., Sarlöv Herlin, I. & Swanwick, C. (2018). *Routledge Handbook of Landscape Character Assessment*. London: Routledge.

Förster, F., Großmann, R., Iwe, K. & Kinkel, H. (2012). *What is Landscape? Towards a Common Concept within an Interdisciplinary Research Environment*. *eTopoi*, (3), 169-179

Gerber, J. D., & Hess, G. (2017). *From landscape resources to landscape commons: Focusing on the nonutility values of landscape*, *International Journal of the Commons*, 11(2), 708-732

Golkar, Koruosh (2007) *The visual environment of the city, the evolution from a decorative approach to a sustainable approach*. *Environmental Science*, 5(4), 95-114, Hemmati, Morteza and Sabunuchi, Paricher. (2021) *Perceiver, perceiver, product of perception (Evaluation of the true interpretations of beholders from the components of landscape definition 56(13) 29-14)*

Khakzand, Mehdi, Mohammadi, Maryam, Jam, Fatemeh, Agha Bozorgi, Korosh, (2013) *Identifying the effective factors on the design of urban bodies with emphasis on aesthetic and environmental aspects*. *Scientific Research Quarterly of Urban Studies*, - 10: 26-15

Matlak, Jan (2014) *Familiarity with environment and landscape design (translated by Tehran City Parks and Green Spaces Organization)*. Tehran: Tehran City Parks and Green Spaces Organization.

- Mirkarimi, Seyed Hamed, Saeedi, Sepideh, Moham-madzadeh, Marjan, Salman Mahini, Abdol Rasool, (2013) Application of PCA method in evaluating the visual quality of landscape (case study: Pilgrimage area of Golestan province, *Environmental Science*. 40 (2) 462-451
- Moghadisi, Negin Sadat, Haqit Bin, Mehdi (2014) Evaluation and comparison of visual quality of urban highway case study: Modares and Niayesh highway. *The 7th National Conference on Urban Planning and Management with Emphasis on Urban Development Strategies, Mashhad, Mashhad Islamic Council, Ferdowsi University of Mashhad, Mashhad Municipality*.
- Nijhuis, S. (2011). *Visual research in landscape architecture*. V. 2. Amsterdam: TU Delft.
- Nishimura, K. (2019). *The Aesthetic Appreciation of Landscape*. In A. Verissimo Serrao & M. Reker (Ed.), *Philosophy of Landscape: Think, Walk, Act*. Lisbon: Center of philosophy
- Ode Sang, A., Tveit, M. & Fry, G. (2008). *Capturing Landscape Visual Character Using Indicators: Touching Base with Landscape Aesthetic Theory*. *Landscape Research*, 33(1), 89-117.
- Polat, A. (2015). *Visual Quality Assessment in Landscape Architecture*. Conference paper. *International Academic Conference at Florance, Italy*. 637- 648.
- Relph, E. (1976). *Place and Place lessness* . London: Pion.
- Rezazadeh, Razieh, (2006) *Principles and criteria of organization and rules and regulations of urban appearance in construction*, Ministry of Housing and Urban Development. *Research plan of the study and research center of urban planning and architecture*
- Sakieh, Y. Gholipour, M. Salmanmahiny, A. (2016). *An integrated spectral-textural approach for environmental change monitoring and assessment: analyzing the dynamics of green covers in a highly developing region*. *Environ Monit Assess*. 188: 1-19.
- Tudor, C. (2014). *An Approach to Landscape Character Assessment*. London: Natural England.
- Watmann, F. M., Frick, J., Kienast, F., & Hunziker, M. (2021). *Factors influencing visual landscape quality perceived by the public. Results from a national survey*. *Landscape and Urban Planning*, (208), 1-10
- Zube, E.H.; Sell, J.L.; & Taylor, J.G. 1982. *Landscape Perception: Research, Application and Theory*. *Landscape Plan*, 9, 1-33.

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