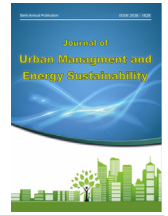


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## ORIGINAL RESEARCH PAPER

### Explaining the evaluation model of the green roof concept in urban landscape quality with an analytical approach

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#### ABSTRACT

The idea of creating a garden on the roof and cultivating it was used by Iranians 2500 years ago but today it is an important solution to make a better environment. This conventional technique is a living ecosystem, with many advantages. Green roofs in terms of quality in recent years with the goals of environmental protection, promotion of social-cultural interactions and improvement of economic conditions, and improvement of the current state of energy consumption. the main research question includes, how does the green roof conceptual model affect a sustainable urban landscape pattern? and what mechanism can the components of the green roof work in the direction of the quality of the sustainable urban landscape? In this research, to achieve the basic definitions and theoretical approaches in the field of an urban landscape, sustainable urban landscape, green roofs, and their design patterns, the information obtained from reviewing data, library documents, and internet resources are analyzed and reviewed and after extraction of important influencing factors 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. As a result, visual scale and sense of place (4/85 and 4/84) have more impact on the quality of the urban landscape in the concept of green roofs. In conclusion, 9 indexes can be evaluated in each case study by using the proportional conceptual model for evaluation.

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## 1. INTRODUCTION

The green roof is not a new invention, grass roofs, rooftop gardening, living roofs, bio roofs or garden roofs are conventional and traditional building techniques in many parts of the world with an ancient background, which can be He pointed to the first examples of it, the Hanging Gardens of Babylon in 500 BC. (Butt et al., 2017) The idea of creating a garden on the roof and cultivating it was used by Iranians 2500 years ago and on the roofs of ziggurats. The hanging gardens of Babylon were not gardens that were suspended in the air, but green spaces that were located on the roofs and skylights of several buildings. (Nguyen et al. 2022) This conventional technique as a living ecosystem, with its many advantages that we will discuss further, is a positive and effective step towards improving the quality of the urban landscape, the ability to create a favorable environment in urban environments, refining and improving air quality, and establishing thermal balance. (Pelorosso et al., 2016) It will reduce the effects of heat islands. (Ziter, 2016) Green roofs in terms of quality in recent years with the goals of environmental protection, promotion of social-cultural interactions and improvement of economic conditions, improvement of the current state of energy consumption, low per capita green space in the country, the possibility of optimal utilization of urban lands, proper management of sewage surfaces and attention to aesthetic issues have grown significantly and made this issue more important than before, but by studying and examining the existing examples in the country, it is still responsive in terms of performance in reducing energy consumption, design, implementation, and maintenance. and they lack effective efficiency and have major problems that will require providing a suitable design model. Even though green roofs are beautiful and provide a pleasant and pleasant environment for work, life, and social interactions. compared to traditional roofs, it helps to return the initial investment during the life of the building, many other benefits in urban environments such:

1) compensation of existing pollution, 2) reduction of heat island effects, 3) improvement of control management sewage, in such a way that the sewage generated in the buildings can be

used for green roof irrigation after purification, 4) reducing drainage, 5) saving energy consumption, 6) increasing the durability and lifespan of roof coverings, 7) adjusting water and air, reduction of winter cold, preservation and ecological balance of the city, 8) reduction of sound pollution and insulation against noise, 9) increase of green space per capita and improvement of the quality of the environment, vitality and dynamism of the city. Currently, the green roofs in the country, in practice, due to the existence of research gaps and the lack of a design model and the following main reasons: 1) lack of attention to the qualitative aspects of the urban environment in the urban planning system of the country, 1) lack of provision of sufficient water resources, materials (suitable soil), etc., 2) lack of proper use of gray wastewater and control of floods and runoff and proper management of rainwater, 3) lack of coordination of the type and vegetation suitable for the climate of the region and their cultivation and maintenance, 4) Creating and imposing extra load and heavy weight on the roof and structure, 5) Expensiveness of current methods and lack of complete and professional systems for maintenance, not only so far it has not been useful and responsive and it has benefited from positive and effective aspects. It has not been seen, but its destructive effects and negative aspects have been seen in the examples implemented in the country, to the point where the implementation of green roofs has been neglected in most of the country's buildings. Therefore, in large cities and towns, contemporary urban landscapes, due to the influence of various factors on how their texture is formed and the speed of its changes, on the other hand, the repetition of similar urban landscapes, do not represent the characteristics of their natural, cultural and historical background. The green roofs of architectural buildings in medium scales can contribute to a better understanding of the audience from an urban perspective. In the current cities of the country, the lack of an organizing structure for green roofs has caused the disintegration of the theme and its lack of integration, which in a way has led to weak connections in the urban landscape, which is one of the reasons for the urban identity crisis and the lack of creating a sense of place in the city. This is

also the attitude towards the city.

1) Currently, the main concern and problem in the country, in addition to the lack of non-renewable resources, and climatic and ecological stability, is the identity crisis caused by nature, which this pathology is investigated and the main and fundamental problem of research is how to use The decisive role of green roofs and walls and the development of green space partitions and sustainable architecture and its objective effects, a practical solution and a model of green roof design

2) By presenting a green roof design model and increasing green space per capita in dense urban areas, it improves the quality and climate conditions while reducing the effects of urban heat islands. Also, with the development of green roofs, we can mention the sustainability of the urban landscape by creating its dimensional continuity, including functional and visual, along with aesthetic and psychological effects.

3) Considering the long-term consequences of unprincipled constructions and physical expansion of cities, which lead to the reduction of green spaces, the creation of an unstable environment and an inappropriate urban landscape, and visual pollution - which itself has an impact on the mental health and comfort of citizens - and other problems of this kind. as well as the principles and regulations and the design model based on sustainable architecture have been ignored, which have created major problems in the city and urban landscape and citizens' well-being, therefore, considering the problem that has arisen in high-rise buildings and also large buildings The scale and urban development without considering the principles and criteria of sustainable architecture, we can point to the role and importance of providing a green roof design model to improve the quality of the urban landscape and achieve a sustainable urban landscape. Today, cities benefit from two geographic symbols and natural, social, economic, and artificial environments (man-made environments). Today's people constantly change these two symbols in their daily activities and in their struggle to live their daily life and earn their living and build a house, either as a shelter or as an investment. and it changes the urban

environment that In this process, green spaces, gardens, and forests have been transformed into high-rise buildings, and with the advancement of technology and industry, the pattern of life has undergone a transformation and the need to exploit natural resources has also increased, so that the irrational exploitation of resources naturally leads to their destruction.

Due to the improvement of social, economic, and environmental conditions, green roof has been included in the planning of most advanced cities in the world, and even in the 19th topic of the National Building and Housing Regulations regarding energy consumption, there is no mention of it. Buildings usually have a lot of heat loss through the roofs and the energy consumption of the top floor units increases, so presenting a green roof design model is a solution for this problem. (Correa et al., 2016) (Mahmoudi Zarandi, Pakari, 2013) The implementation of green roofs is due to existing research gaps and lack of attention to the principles of sustainable architecture, lack of a suitable platform such as providing the required water, lack of proper management of runoff and rainwater, lack of familiarity of employers with various advantages such as long-term savings in energy and Their easy implementation, the vertical growth of megacities, low per capita green spaces according to international standards and inappropriate distribution at the neighborhood level, and the lack of necessary infrastructure and legal facilities, have led to the creation of an unstable urban landscape. (Zurbuchen et al, 2010) With this attitude and the need to reduce problems, creating green buildings and benefiting from sustainable architectural rules will become more necessary and important because of the current environmental problems. Also, in today's world, sustainable and organic architecture is considered one of the most important and up-to-date topics, and the development of green roofs in the contemporary urban planning system of the advanced countries of the world has become an executive order, and the study of the effects of green roofs on thermal islands, among other benefits, has shown that compared to the normal roof, the green roof has many advantages, such as increasing the power and ecological diversity, establishing balance and reducing the

temperature, and has a more balanced humidity. On the one hand, the influential conceptual dimensions of green roofs, such as climate, ecology, and environment (taking into account the economic-cultural background) of urban spaces, will provide the possibility of providing suitable solutions to increase the quality of a sustainable urban landscape to improve the environment for citizens. Therefore, the main research question includes the following:

1. How do green roof design patterns affect a sustainable urban landscape?
2. What mechanism can the components of the green roof work in the direction of the quality of the sustainable urban landscape?

## 2. MATERIALS AND METHODS

### Methodology

In this research, to achieve the basic definitions and theoretical approaches in the field of an urban landscape, sustainable urban landscape, green roofs, and their design patterns, the information obtained from reviewing texts, library documents, and internet resources is analyzed and reviewed. First, the effective criteria in 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 initial proposed indicators that are tested and finally, the research framework is extracted.

### Research background

the review of the background of the research in the position of sustainable urban landscape architecture in the area of urban green roofs which is discussed in micro-scale architecture, so far no research has been observed that has independently investigated the research methods and approaches comprehensively, and also the method A detailed evaluation of the urban landscape with a sustainable approach in the green roof area has not been defined as a comprehensive method. But in the dimension of landscape architecture, urban landscape, and centering on the concept of ecology as one of the comprehensible examples 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 expansion of the concepts of sustainable urban landscape and green roofs in terms of explaining the structural model of the research, which will lead to the formulation of the proposed indicators, is considered a new aspect of this research. In addition to that, creating a practical and executive relationship between the green roof design model and the quality of the sustainable urban landscape and presenting the green roof design model and promoting it in future constructions as an effective principle in the detailed plan of the city as well as the landscape. The idea of improving the urban environment and improving the quality of the urban landscape can be expressed as the innovation of the current research. (Tab. 1)

Table 1: Research background of green roof concept in urban landscape

Researchers	Year	Functional Scale			Methodology	Field of study	Results
		Macro	Mid.	Micro			
Steiner	1991	-	*	-	Ecological design method	Landscape architecture and environmental design	How to explain problems and opportunities according to the principle of the urban landscape, creating a continuous structure in building landscape design

Hersperger	1994	-	*	*	Ecological urban landscape planning and Principles of green architecture planning	Landscape Architecture and urban design	Clarifying the pattern of ecological ownership and specifying urban green spots in the field of architecture and urban planning
yang	1995	-	*	*	Architectural design of urban landscape	Landscape Architecture and urban design	Presenting a method of evaluating the criteria of design ideas and creating a sustainable urban landscape plan
Diagle	1998	-	*	-	A comprehensive model of urban landscape ecology	Landscape Architecture and urban design	Providing an economic framework for developing an ecological urban landscape concerning green architecture
Marcus	1998	-	*	*	Architectural urban landscape design	landscape architecture	Explaining the relationship between landscape architecture and ecological planning on a micro-scale
Fernandez et al.	2010	-	*	-	Ecology planning method	Landscape architecture and environmental design	The method of reviewing and analyzing urban landscape components and how to adapt the use based on ecological principles at medium and small scales
Bertoncini et al.	2012	-	*	*	The methodical process of sustainable urban landscape planning	Urban Studies	Presenting the way of functional status in ecological systems in connection with the urban landscape based on the patterns of the green building structure
Akman	2017	-	*	*	Parametric method	Landscape architecture and green architecture	Explanation of the parametric method in the evaluation of the urban landscape with a sustainable urban landscape approach
Chen et al.	2021	-	*	*	BIM evaluation method	Landscape Architecture and urban planning	Presenting an urban landscape design model based on the relationship between landscape architecture and environmental roofs
Appolloni et al.	2021	-	*	*	The method of visual simulation of the urban landscape in the field of ecology, visual preference, and landscape evaluation	Urban and green landscape architecture	Presenting the compiled structure of evaluation based on the evaluation of urban landscapes
Viavo et al.	2022	-	*	*	Combined multivariate method	Landscape architecture and urban architecture and design	Providing an optimized architectural urban landscape framework in connection

### 3. DISCOSION AND FINDING

#### Landscape

The concept of landscape was born in the fifteenth century at the same time as the Renaissance and modernity began in Europe (Abbasi et al., 2020). Historically, this is the result of the modern distinction between the physical world and the conceptual world of phenomena (Berque, 1995). It is known as the ontological basis of modernity, and it posits an unlimited modern subject, the first act in the emergence of the landscape. At this time, by breaking the

unity between man and nature, modern man has tried to individualize the landscape and create a landscape in nature (Bubnova et al, 2012, Cardinale et al, 2012). And it is a subject that is proposed and created by modern absolute reason (Benvenuti et al., 2014). The study of landscape with one of the objective or subjective approaches of researchers is rooted in Cartesian duality. Therefore, many attempts have been made to fill this gap. Some recent philosophers such as Hegel, Husserl, and Heidegger have made the bipolar structure of phenomena objective or subjective by introducing existentialism and phenomenology. Heidegger

proposes a topological model to think about the relationship between people and landscape as a matter of “existence and essence” in the world and its essential being (Fuller, 2009) at the same time that the duality to define landscape and place with an intermediate approach influenced by Object and mind are replaced. It is the result of the interaction between the human mind and the environment, which creates a new unitary structure that is inseparable (Gaston, 2009).

The landscape is the outer space of any place that is in the field of view and is located in the landscape, which includes a set of visual information such as the ground and the position of objects and artificial elements and structures, as well as vegetation, water, and sky, which is the effect It is known from the environment and landscape. (Grimm et al., 2008) James Corner first proposed the term landscape as urban development in a series of seminars in 1990 under the titles of constructive landscape and restorative landscape. In 1997, Charles Waldheim formulated the phrase landscape urbanism in the 1999 master’s academic program at the Faculty of Architecture in England and established it to attract students in this field. A focus on landscape urbanism in the Master of Architecture program under Waldheim’s supervision at the University of Illinois School of Architecture at the University of Chicago began around this time. Charles Waldheim proposed landscape urbanism in 1996 as a description of an emerging model for the professional experience of landscape architecture and urban design. In this view, the landscape is the central emphasis of urban development. According to this approach, the buildings and other main infrastructures of the city should be designed for the landscape. (Bill Harz, 2004, quoted by Hofmann et al. 2018) When we use the term landscape, we are emphasizing the relationship between the world and ourselves. It is like a window through which we can look at the world through the eyes of our native culture. In the introduction of the book Tafsir of Environment and common landscapes, Mining writes: Our environment is maintained by creatures and our environment and landscape is displayed by culture, and our eyes define the environment and landscape and our mind interprets it. The environment and landscapes in

which humans live are the history of culture and convey its concepts. (Zanaga et al., 2022) Simon Bell in the book Landscape: Pattern, Perception, and Process based on Berlnt’s opinion considers the environment as everything; Nature, culture, and man (Galpern et al., 2011) and in a way defines the landscape as it is seen in settled areas, which man reacts to. However, this mechanism is the result of many complex interactions between Man and nature. Every landscape gets a special character based on the way people relate to the physical and natural environment in the past. Environments and landscapes are the momentary expression of thousands of ecological and cultural factors. (Klaasen et al., 2008) Behzadfar (2014) in the “Dictionary of Urban Design Concepts” culture, the constituent elements of the urban landscape are divided into three sections: physical factors, non-physical factors, and The human qualities of the case will check. In a way, the urban landscape is the citizens’ understanding of the city, which is formed through the perception of its symbols (the physical dimensions of the city) and the association of meanings associated with them (mental and memory dimensions). It has a cultural and functional identity (Mansouri, 2017). The following definitions can also be used:

- “Visual, physical, spatial, activity, identity and environmental dimensions and characteristics of localities and urban areas together form the urban image” (Goines, 2007).
- The urban landscape is a tool for reading the city as a quote and “can show successive chapters of the history of an urban society”. (Golkar, 2012)
- The urban landscape is an objective reality that can be seen in the observation of each person, in other words, the urban landscape is a description of the physical reality of a city, and this description is empty of the image that is seen through the experiences of the individual. The doer plays a role in his mind, The key features in the urban perspective include sustainability, identity, beauty, and unity (Mahmoudi, 2016).
- Kevin Lynch considers three factors, perceptual, physical, and functional, to be important from an urban perspective (Rezazadeh, 2016).
- Bentley and colleagues examine the urban landscape in three dimensions: visual, functional, behavioral, and meaningful.



- The scope of the meaning of the landscape and the complexity of its concept on the one hand and human interaction with the environment in this vast scope on the other hand, have prompted researchers to use different approaches in their research. But as mentioned earlier, researchers are trying to reduce the gap between objectivity and subjectivity and study a paradigm with a holistic approach, which is evident in their definitions. Indeed, the concept of “scene” has different meanings depending on the person who observes or discusses it (Swaffield, 1991). Some of them are mentioned below: J. Appleton defined the landscape as “a kind of platform for the whole stage of human activity” (Madre, 2014). Adam et al. (2018) define a landscape as “a geographic unit characterized by a specific pattern of ecosystem types, shaped by the interaction of geographic, ecological, and human-induced forces”. Or “landscape refers to a common perceptible portion of the earth’s surface” (Marzluff, 2008). Hokma (2015) in his research to investigate the common perception of landscape explains which main image of people of the landscape is related to some terms which include nature, beauty, country, city, and garden. He also adds: “The

results show the positive concept of vision and its high relevance for people”. Figure 1 shows the field of meaning in people’s imagination from perspective. Lowenthal (2007) also adds: “Scenery is the fundamental heritage of all physical and mental elements and is an all-encompassing and inescapable whole that inspires and shapes much of what we learn and do.” The landscape is where we all build our homes, do our work, live our lives, and build our dreams” (Mcdonald, 2008). Pierre Donadio also believes that landscape is an asset. It is common to all people and includes both the geographical aspect and the human inhabitants. In fact, “a landscape is a place that its inhabitants deliberately perceive to create a personal and institutional habitat from it” (Mckinnery et al., 2019). (Fig.1)

Fig 1: Landscape and realms of research

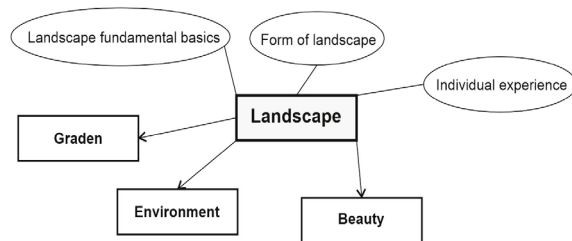


Table 2: The historical course of the concept of the urban landscape from the perspective of researchers and its approaches

Theorists	Viewpoint	Features and characteristics	Approach
Sitte Burnham	objective (object)	- Urban landscape as a two-dimensional view, design of windows - Creating a new urban landscape based on artistic principles and methods - Using decorative elements and memorial spaces	Artistic approach
Le Corbusier	objective (object)	- Urban landscape as a three-dimensional spatial structure - Lack of attention to aspects of urban beautification - Minimal beauty (avoid decorations) - Emphasis on purity and standardization in the use of volumes, materials, and colors - Attention to urban form and urban planning	Functional approach
Lynch Appleyard	Objective and Subjective	- Urban landscape as a socio-spatial structure - Attention to historical and cultural resources - Urban landscape, a reflection of social diversity and ethnic differences - livability and public life	Perceptual approach
Naser Kaplan	Objective and Subjective	-	Contextual approach
Calthrop Macharg	Objective- Subjective	Social structure - Stable space - Emphasis on aesthetic concepts, identity, sense of place, Human Scale	Sustainability approach

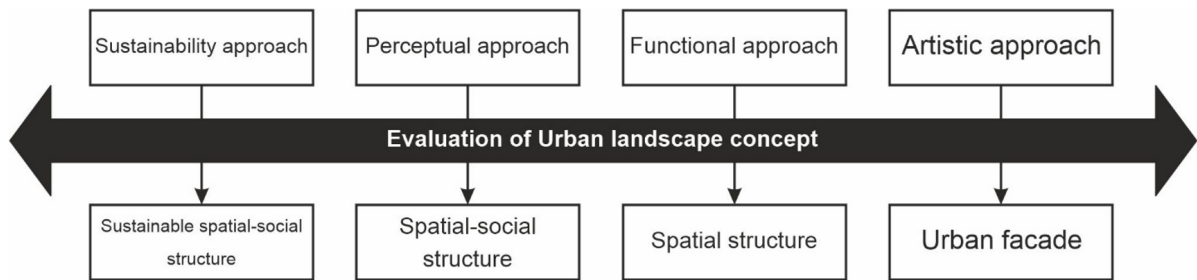


Figure 2. Evolution of the urban landscape concept and its approaches

The urban landscape can be considered a paradigm that has a set of opinions, theories, laws, patterns, measurements, and implementation methods. By examining the history of urban developments and examining different theories of urban studies and related trends such as architecture, urban design, and urban planning, four main perspectives can be proposed (Molineux et al., 2015) for the urban landscape, which are artistic, functional, Background and environment. It is true that the urban landscape has gone through an evolutionary process and has wider dimensions, but it should be kept in mind that some programs and designers continue to use their past approaches and designs, and by neglecting new approaches, the path leading to It has been and continues to be, which has led to the failure of projects and urban problems. According to Table 1, each of the design approaches has set criteria as its main goal and put them at the forefront of designs and research. Based on this, it can be generally stated that the factors of “aesthetics”, “functionality”, “identity” and “ecology” are the four main goals of the urban landscape, which are evident in the work of designers and theorists. In the past decades until now and as can be seen, due to the difference in goals, movements, and styles have been created.

*Urban landscape ecology*

It can be said that the integration of landscape ecology and urban ecology led to a new proposal, which is called urban landscape ecology. Cities are spatially expansive and complex adaptive systems that we call landscapes. Undoubtedly, cities are the main place for the future of human life, so most landscape ecology studies will inevitably focus on cities (Nagase et al., 2010). Wu et al. (2013) simply mention that the study of urban landscape ecology is the same as urban landscape

ecology. Specifically, the science of studying and improving the relationship between urban landscape patterns and ecological processes to achieve urban sustainability. To characterize the study areas in urban landscape ecology, these researchers proposed three key components: patterns of urbanization, effects of urbanization, and urban sustainability. In this regard, Modero et al. (2018) reviewed the literature and related research between 1986 and 2016 to clarify the focus of attention in urban landscape studies and extracted the most common terms in urban landscape ecology research, which include landscape ecology, structure Landscape, landscape change, biodiversity, approaches, gradient, vegetation, GIS and remote sensing. Green Roof as an urban ecosystem

Buildings alter the flow of energy and matter through urban ecosystems and often cause environmental problems. These problems can be partially reduced by changing the surface characteristics of buildings. Roofs can represent up to 32% of the horizontal surface area of built-up areas (Yang et al., 2012) and are important determinants of the energy flow and relationships of buildings. Adding vegetation and soil to roof surfaces can reduce several negative effects of buildings on local ecosystems and reduce the energy consumption of buildings. Living or green roofs have also been shown to increase sound insulation, fire resistance, and longevity of the roof membrane (Zanaga et al., 2022). They can reduce the energy needed to maintain indoor climates (Rayfield, 2011) because growing vegetation and plant habitats intercept and scatter solar radiation. Green roofs can also reduce stormwater runoff from building surfaces by collecting and retaining precipitation, thereby reducing the volume of runoff to stormwater infrastructure



and urban waterways. Other potential benefits include green space amenities, wildlife habitat, improved air quality, and reduced urban heat island effect. Architects have used green roof technology around the world, and policymakers and the general public are becoming more aware of the benefits of green roofs. Although green roofs are initially more expensive to construct than conventional roofs, they can be more cost-effective over the life of the roof due to energy savings and the longevity of the roof membranes (Herera et al., 2017). Although green roofs represent a distinct type of urban habitat, they are often considered an engineering or horticultural challenge rather than ecological systems. The environmental benefits provided by green roofs derive from their function as ecosystems. The first goal of this article is to describe the history and components of living roof ecosystems. The second is to examine how the structure of a green roof—including vegetation, growing medium, and roof membrane—determines its performance.

Delphi method applies

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 the judgment of reaching a consensus among the 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 started with the collection of questionnaires in the first stage of the research and the extracted data were analyzed through descriptive statistics

and qualitative analysis. 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 34 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.

*Findings of implementing the Delphi method first round*

In this round, the panel members identified 17 factors out of 34 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 related to the implementation of the first stage of questionnaire distribution are given in the following table. Factors of resilience, vegetation, visual influence, activity, stimulus, and decorations have been removed from the Delphi process due to their average importance of less than 2.5. (Tab.3)

Table 3: Phase one of the fuzzy method in compiling the final indexes of an urban landscape based on the concept of a green roof

No.	Factors	Response	Average	standard deviation	Min.	Max.
1	Sense of place	16	4/29	0/45	1	5
2	Physical identity	16	3/35	0/62	1	5
3	Resiliency	16	2/10	0/41	1	5
4	Life Quality	16	3/29	0/66	1	5

5	Mental health	16	2/05	0/45	1	5
6	Green Space	16	1/89	0/31	1	5
7	Legibility	16	3/85	0/35	1	5
8	Proportions	16	3/34	0/51	1	5
9	Visual penetration	16	1/68	0/54	1	5
11	Texture and Materials	16	3/55	0/45	1	5
12	Size	16	2/04	0/55	1	5
13	Urban form	16	1/98	0/40	1	5
14	Activity	16	2/22	0/25	1	5
15	Spatial quality	16	3/25	0/65	1	5
16	Visual scale	16	3/41	0/39	1	5
17	Visual clarity	16	3/44	0/55	1	5

### 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 9 factors out of the 17 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 table below. Kendall's coordination coefficient for the answers of the members about the order of the 9 factors that had a high and very high influence in this round was 0.775. (Tab. 4)

Table 4: Phase one of the fuzzy method in compiling the final indexes of an urban landscape based on the concept of a green roof

No.	Factors	Response	Average	standard deviation	Min.	Max.
1	Sense of place	16	4/54	0/45	1	5
2	Physical identity	16	4/38	0/53	1	5
3	Life Quality	16	4/71	0/56	1	5
4	Legibility	16	4/72	0/68	1	5
5	Proportions	16	4/24	0/48	1	5
6	Texture and Materials	16	4/12	0/45	1	5
7	Spatial quality	16	4/35	0/78	1	5
8	Visual scale	16	4/75	0/49	1	5
9	Visual clarity	16	4/71	0/49	1	5

### 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 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 9 factors was 0.789 (Tab. 5).

Table 5: Phase one of the fuzzy method in compiling the final indexes of an urban landscape based on the concept of a green roof

No.	Factors	Response	Average	standard deviation	Min.	Max.
1	Sense of place	16	4/84	0/65	1	5
2	Physical identity	16	4/28	0/93	1	5
3	Life Quality	16	4/51	0/86	1	5
4	Legibility	16	4/92	0/48	1	5
5	Proportions	16	4/34	0/68	1	5
6	Texture and Materials	16	4/22	0/55	1	5
7	Spatial quality	16	4/25	0/88	1	5
8	Visual scale	16	4/85	0/79	1	5
9	Visual clarity	16	4/61	0/79	1	5

*Reasons for stopping polling*

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 9 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 0.789. 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 9 influential factors in developing the research framework in the third round compared to the second round only increased by 0.025, 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.

Table 6: Proposal research model

The dimensions, indicators, and indexes in explaining the urban landscape quality mechanism based on the green roof concept				
Dimension	Components	Index	Index type	Measurement
Urban landscape	Visual-perceptual	Visual scale	Quantity	Visual preference
		Visual clarity	Quantity	
	Environmental	Spatial quality	Quantity	Spatial value
		Legibility	Quantity	
	Aesthetics	Texture and Materials	Quantity	Visual assessment
		Proportions	Quantitive	
Green roof	Ecology	Life Quality	Qualitative	Questionnaire
	Socio-economic	Sense of place	Qualitative	Questionnaire
				Qualitative

### 3. RESULT AND CONCLUSION

The proposed research model is based on the convergence of researchers' ideas and methods that can investigate the effective nature of the green roof in the way it affects the urban landscape, while the formal quality of the green roof, in addition to improving the urban environment, can contribute to the sustainability of the urban landscape in a larger perspective. and help in the middle scale as well. (Fig.3)

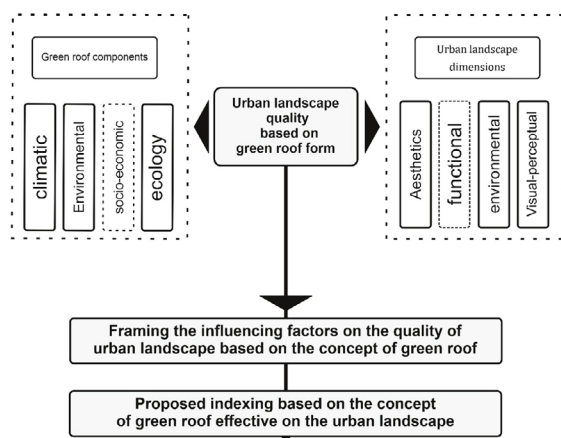


Table 4: Phase one of the fuzzy method in compiling the final indexes of an urban landscape based on the concept of a green roof

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