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Original Research Article

Role of Space Syntax in Landscape Approach Analysis*

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Abstract | Problem statement: Space syntax is a theory and method that recognizes the space configuration and enables its analysis. Space syntax expresses the intrinsic features of space tangibly and quantitatively by studying space quantitatively. It makes this method more practical and increasingly important. Also, no model can calculate the landscape's subjective and objective aspects by computational and measurement methods in the landscape area. Given that the space syntax theory is a quantitative method that not only addresses the physique but also considers the social issues, such as activities, it seems that it has the capabilities and capacities that can help us evaluate the landscape. This research seeks to achieving the specific components of the landscape to fill in the gaps and weaknesses of conventional measurement methods and quantitative study of the landscape's objective and subjective aspects and wants to answer the question that, How can the syntax method of space be used for landscape analysis?

The current study addresses the content analysis to recognize the space syntax and its fundamental theories and concepts using a mixed method of descriptive-analytical and deductive explanation. These concepts are then analyzed along with the landscape concepts to achieve the space syntax efficiency in the landscape. The landscape is a subjective-objective phenomenon. The landscape features depend on the objective (physical features of space) and subjective features (meaning). The subjective factor is classified into two groups of visual and drama groups, which have different measurement and evaluation methods and capabilities. The visual factors are perceived reflectively and sensually, and drama factors depend on the rational process and establishing a relationship between its different parts. Space syntax can be used to analyze some of the landscape factors and has a deficiency in analyzing others. The objective factors of the landscape can be studied using space syntax due to their syntax feature. However, the more semantic the factors, the more inefficient is the method of space syntax for recognizing and analyzing space.

Keywords | *Space Syntax, Landscape syntax analysis, landscape approach in defining space, landscape components.*

Introduction| Space syntax[1] theory was developed by Hillier and Hanson (1984), which is a method to quantitatively analyze the spatial relations in a building of urban systems (Jeong & Ban, 2011, 2442). Space syntax is a method to analyze the space in a non-geometric way, which is considered to understand the space function and recognize its intrinsic features. This method can analyze the space integration of space to other adjacent spaces and the spaces of a complex. Although space syntax theory is not a new theory, due to the tangibility of this theory and the development of this method in the computer are and the related software, it is still one of the significant and updated theories in architecture and urbanism in such a way that "among the logical research systems of architecture and

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urbanism, the space syntax theory has been considered more than other theories in the literature of the contemporary architecture and urbanism (Grot & Wang, 2005, 307).

This method claims that it can calculate the space configuration of the built environment and compare it to the socio-economic data. "Since there is a direct relationship between the space configuration and urban functions, the analysis of the space configuration provides a powerful tool for designing, planning, maintaining, and improving the urban functions" (Penn, 2008). Accordingly, space syntax presents a set of modeling methods and techniques to analyze the space configuration. These techniques are based on the fundamental concepts of human behaviors, such as movement, visual perception, and density that link the physical body to the people. The relationship between configuration and function, or in general, the model of society and space, which is in the space syntax, provides the possibility to use this model to study and analyze the landscape, which is defined by subjective-objective aspects.

Research background

The space syntax theory was proposed in the late 1970s By Bill Hillier in the Bartlett Faculty in the UCL in London (Hillier & Hanson, 1984). Hillier (2007) presented a novel method to analyze the constituent components of space. Some great architects have used this method. Although similar attempts were conducted at the same time in the Georgia Institute of Technology and Massachusetts Institute of Technology, these theories were not as influential as the theory of Bill Hillier and Julian Hanson in architecture. In east Asia, Kim & Shin (2007) evaluated the characteristics of using sidewalks and land uses, network, and sidewalks capacity in the central part of Seoul using this theory. "The academics and researchers of Iran also become familiar with the theoretical foundations of this theory systematically in 2002" (Abbaszadehgan, 2002). Various studies have been conducted using the space syntax in the architecture space, and especially urban space. In the urban landscape, the practical examples can be mentioned in the urban infrastructures and planning, morphology, and social issues, such as security and economy as follows: transportation planning and public transportation systems (De Koning, Van Nes, Ye & Roald, 2017), flexibility and urban planning for hazards and disasters (Mauriera & Karimi, 2017), social media and the common presence (Shen & Karimi, 2016), spatial and environmental recognition (Dalton, 2003; Marcus, Giusti & Barthel, 2016), urban dispersion and regional planning, walkability studies (Dhanani, Tarkhanyan & Vaughan, 2017), bicycle-oriented studies (Raford, Chiaradia & Gil, 2007; McCahil & Garrick, 2008), the integration of space syntax in GIS: new prospects for urban morphology (Jiang & Claramunt, 2002), urban regeneration and updating the slums (Karimi & Parham, 2012), Transit-Oriented Development Design and other main infrastructural studies, urban lighting and night-time economy (Dwimirnan & Karimi, 2017). These studies analyze the space data using the space syntax method and present practical results. However, the space syntax efficiency in the landscape has not been addressed. Also, its weaknesses and strengths have not been specifically presented in the landscape. Therefore, the place of space syntax and its efficiency in the landscape can be obtained by investigating this issue.

Research main questions

What are the specific features of analysis, evaluation, and reading of the landscape approach[2] of space? Can these components be interpreted and read using the quantitative method of space syntax?

Research method

The present research method is a mixed method of analytical-descriptive and deductive explanation. After studying the space syntax and its fundamental theories, this structure is analyzed with the landscape approach of space based on the definitions of theorists. Finally, using the deductive method, the space syntax and landscape are analyzed and evaluated logically (Fig. 1).

The theoretical foundation of basic concepts of Space Syntax

Space syntax is a methodical technique based on a theory that addresses space relations. The space syntax technique, first, "analyzes the space access to analyze the space relations quantitatively. Then, it attempts to determine the complexity of the space configuration in the urban morphology and its impact on the urban life" (Paul, 2011). The next step determines the natural movement potential in each space to its adjacent spaces (Fig. 2).

First, space is defined based on the "Spatial Dichotomy Phenomenon. In this definition, space consists of "Spatial Obstacles" (inaccessible for the perception and navigation) and "Free space" (the remained space between physical obstacles defined as preferable space)" (Tischendorf & Fahrig, 2000; Hargrove, Hoffman & Efroymson, 2004). According to the space syntax theory (as mentioned in Fig. 2), the free space is divided into convex space areas using the topological relations; 1- convex space parameters, 2- Isovist field (analyzing the visible area from a specific point of space), 3- axial lines. Then, the axial lines are drawn, and the graphic map is obtained. These graphic maps (2D map of convex space, axial line map, and segment map) are used to draw the configuration diagram (Graph). The graph presents a network of space connections. This network is used to analyze the connection of a space unit to other spaces in a system (Fig. 3). A topological network (the geometry without angles and distance) can be obtained in the

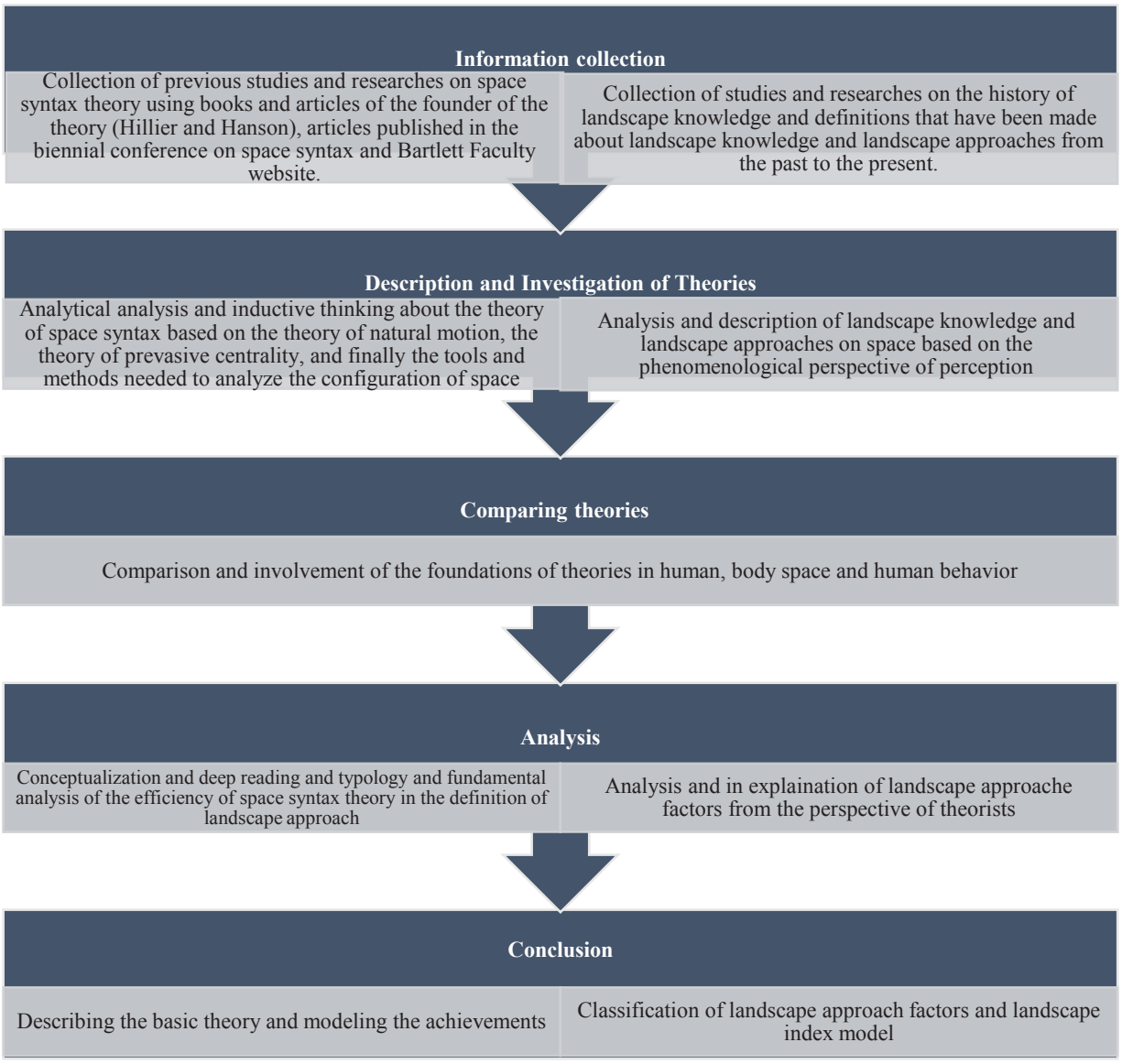

Fig. 1. Research process. Source: Authors.

configuration graph by connecting any line to a node, which represents the space ranking. Binary Matrix can be used to draw this graph and obtain the related algorithms. The output of Depth Map is the space indices of "connectivity", "control", "depth", and "integration" using this algorithm.

Space Syntax with landscape approach

The concept of landscape has changed over the five centuries in the western world along with the scientific achievements in the perception area, physics world, and the areas related to psychology and phenomenology and the change in the human's attitude towards the world. What is perceived from landscape dates back to the second half of the twentieth century: "landscape is an objective-subjective concrete produced by the individual and social interactions of human with the place in a historical and geographical context (Alehashemi & Mansouri, 2017, 43). The landscape is a generality that indicates the two-way relationship between the subject (human or mind) and the object (environment or the outward). The landscape is beyond absolute objectivity or subjectivity. The two objective and subjective aspects are inseparable. Therefore, the objective and subjective aspects of the landscape are simultaneous generalities.

Hillier and Hanson (1984), in a book titled Social Logic of Space, stated a relationship between the form and functions of spaces in the cities and buildings. The space syntax theory is based on the natural movement theory and visual features of the human. In the meantime, the syntax feature (configuration) is the most significant reason for the perception and movement. The movement path and perception form a network that can show the space's interactive behavior or activity. In this network, the

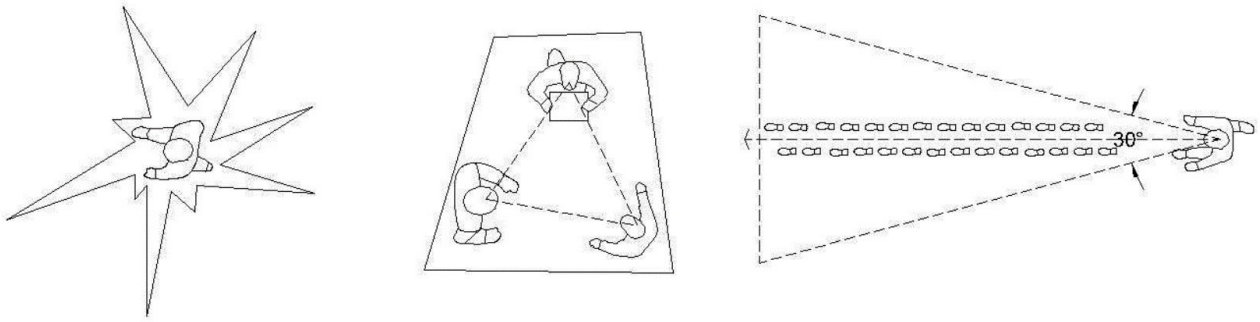

Fig. 2. The visual and movement features of humans. A. a human moves in a linear path, and its view is limited to an axial view and a 15-degree cone in its surrounding. B. the social interactions are formed in a convex space. C. the human has different fields of view by moving in an artificial environment. Source: Hamedani Golshan, 2015; Vaghuan, 2007, 208.

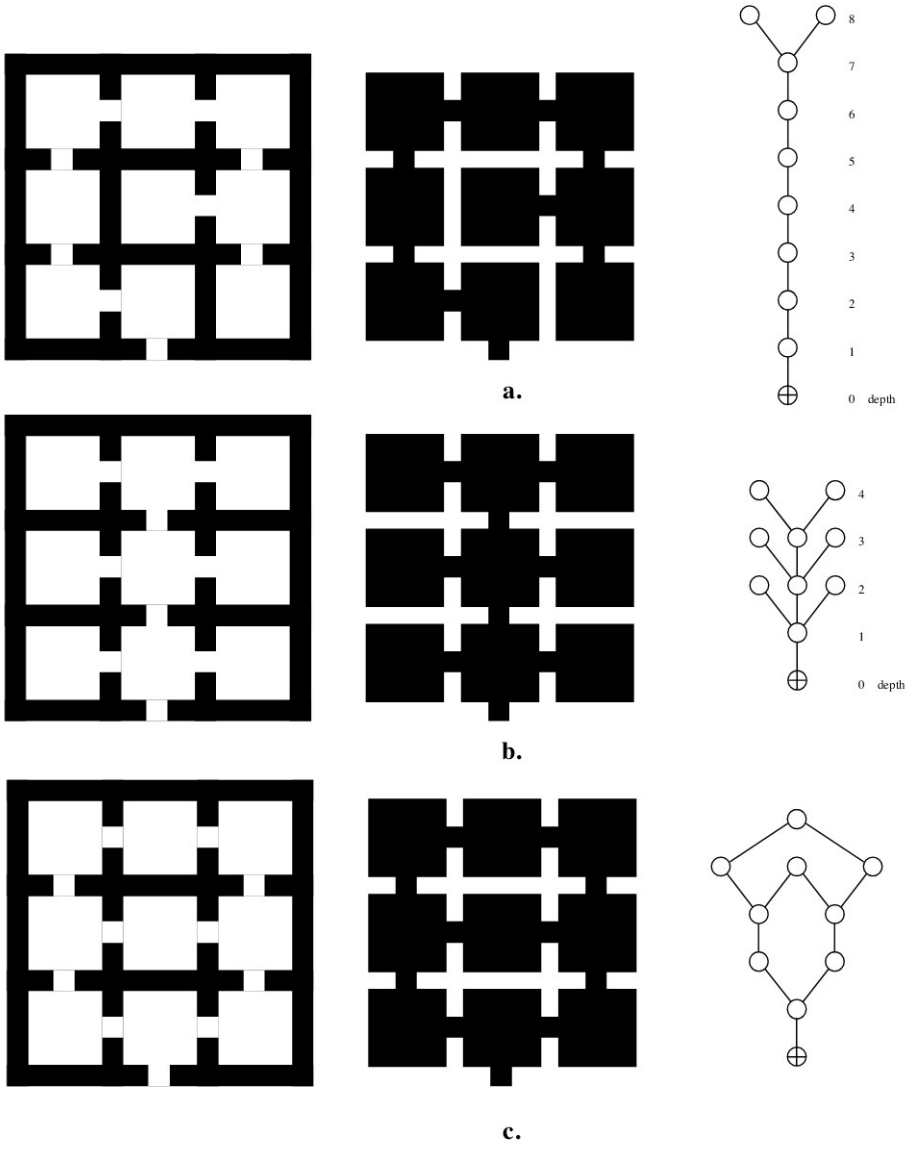

Fig. 3. Space Configuration Diagram or Graph. According to changes in the accesses, this graph has three different shapes, and consequently, three different analyses. Source: Hillier, 2007, 21.

Table 1. Logical analysis and interpretation of space syntax and landscape and the logical comparison of the fundamental basis of two theories, i.e., human and physique. Source: Authors.

Space Syntax			Landscape		
Theory	Discussion	Conclusion	Theory	Discussion	Conclusion
"Natural movement theory" addresses the impact of space configuration in creating the behavioral and social patterns (Hillier, 1993) The configuration is the most significant reason for the pedestrian movement in the city.	Human perception occurs by moving in the artificial environment and facing various fields of views. The emphasis on the objective area of perception is based on external factors.	The perceiver is a subject out of a generality that has a totality of space by moving in the space and perceiving the components and ability in the visual organization of perception.	Landscape is a totality. (Human is considered as the perceiver in the set of the environment components.	Space remains in the human mind after leaving the place. The emphasis on the objective and subjective area of perception based on the human mind	The landscape is a totality in which the perceived and perceiver are together in a totality.
The visual features of human (Hillier & Hanson, 1984) Using the sequential views to perceive the totality of the space	Human perceives the space by seeing.		Human perceives through seeing and, most importantly, by active touch and movement.	The totality of landscape has a higher nature and soul, and its perception requires using more than one sense.	
Space must not be considered as the context for human activities. Space must be considered as an intrinsic aspect of every human activity (Hillier & Vaghaun, 2007, 122).	Therefore, space and activity are not two independent and separated natures, but they are a unit nature that has two different manifestations and complimentary.	The functional aspects of humans are considered.	The landscape is a subjective and objective concrete which is a product of social and individual interactions of humans with the place in a geographical and historical context (Mansouri, 2010).	In definition, landscape is a perceptual phenomenon, i.e., viewer's interpretation. Therefore, the human is considered with all the sensory, rational, emotional, historical, and memorial aspects.	The whole aspect of the human being is considered.

perceiver (human) is a subject out the generality who can have a general perception of space by moving in the space and perceiving the components and the ability in the visual organization. Also, the landscape is a totality in which the perceived and perceiver are simultaneously in a totality. Therefore, the human is not considered an external factor of the complex (Table 1). The landscape is a perceptional phenomenon in the definition. That is, the landscape is the interpretation of the viewer. The objective and material aspects of the landscape provide the ground for realizing the perception in mind. Also, the semantic aspect is more important than the material and physical aspects. The difference between landscape and imagination is that the material aspect plays a role in the landscape, and objectivity and subjectivity are simulations and inseparable.

Given that the space syntax model has been written syntactically in the graph context, it considers the intrinsic features of space by analyzing human activity. However, it does not consider all the aspects of the human being (human mind). Therefore, mind-based qualitative factors are neglected. The subjectivity and objectivity are not addressed comprehensively and simultaneously. However, the landscape is a simultaneous subjective and objective phenomenon, while the human role in the space syntax is specified by human activity. In this theory, the activity and the space of context are the same. Also, the human is considered in the space in terms of human function, and the human mind has been ignored.

Landscape approach factors

The landscape is defined by its various features and characteristics. These characteristics or factors can be recognized from the theorists' perspective. Therefore, by analyzing the texts and theories of the theorists, the factors of the landscape approach and their subjective-objective aspect can be determined. Table 2 presents the classification of the characteristic of the desirable space from the theorists' point of view in different areas of art, psychology, urban planning, sociology, and architecture. The factors stated for the desired space and landscape can be classified in terms of subjective and objective factors to study the landscape approach. The subjective factors are classified into two groups of mental-visual and drama factors considering the theorists' approaches for easier investigation. The mental-visual factors are imaginable and have a general perception. However, the drama-mental factors have the individual description ability (Table 2).

For the easier investigation, the desired space factors of the

Table 2. Analysis and investigation of the theorists' point of view for the factors of the desired space in the subjective and objective aspects. Source: Authors.

Field	Theorist	An objective approach to the desired space	A subjective approach to the desired space	
			Visual	Drama
Painter	Gyorgy Kepes (Kepes,1989)	Using the light, dynamic, and mobile air-supported structures (Flexibility)	Creative visualization, creating an interactive, dynamic, and alive space (public participation and vitality)	-
Architect	Paul Zucker (Pakzad, 2019)	Square, an element for the social interactions (inclusiveness) Enclosure- dimensions and proportions of the open space (physical) (visual dimension and form proportions) There are three limiting elements for the squares: the surrounding walls, the broadness of the floor, and the imaginative ceiling formed from the sky (permeability) Climate comfort	(social interaction and vitality) Activity and movement (sense of a place)	Experiencing human movement in the space (sense of time)
Urban theorist and author	Jane Jacobs (Jacobs, 2007)	Legibility, Mix land use and the eyes on the street, inclusiveness and social- physical justice, organization of the public area and economic development, the nightlife of the public area, The public area of the street and square, the balance and harmony of the visual arrangement (beauty), the function of ecosystem and climate comfort, the public and private hierarchy, and permeability	Security, Social justice, Attractive and vital sidewalk, Park and vegetation as the diversity and sensory richness	Pleasant and desirable (sense of belonging and memorability), Identity, The experience of human movement in space (sense of time)
Architect	Gordon Cullen (Cullen, 2016)	Space arrangement art, The link of the space structures (visual arrangement and integration), physique, The art of relationship (Legibility), physique, organic growth of the cities (flexibility, environmental comfort, visual character, legibility), the environment is perceived based on the objective ability and eyesight (Visual arrangement), Legibility, transparency, and navigation	Sense of place and public experience, Vitality and public participation, The concept of silent marking, Creation of visual words and visual language (Visual character)	Human movement experience in the space (sense of time), memorability
Architect and urban planner	Kevin Lynch (Lynch, 2019)	Legibility and transparency of the urban landscapes, linking to the context (visual integration), hierarchy and enclosure, integrated structure (visual arrangement)	The mental image of the environment, the mental visualization, the image of the environment (public mental visualization), sense of place, and the public experience	Identity
Architect and urban planner	Constantinos Apostolos Doxiadis (Doxiadis, 1968)	-	Sense of belonging to a place, sense of belonging to the time	-
Sociologist	Edvard T Hall (T Hall, 2017)	Human scale, form proportions, and size	Human perception of space (sense of a place), vitality, and social interactions	Identity, culture, and sensory richness
Psychiatrist	Carl Gustav Jung (Jung, 2011)	-	Unified character (integration and visual character), sense of perceiving life (vitality), social interactions, and vitality	The deep interpretation of people and sense of belonging, the experience, and relativity aspects, and memorability

landscape approach (the obtained factors from Table 2) can be classified in the subset of the landscape tripe purposes. "the main purposes of the landscape architecture are classified in three aspects of functional, aesthetics, and semantic" (Mansouri, 2004, 69). Therefore, landscape approach factors can be investigated in functional, aesthetics, and semantic aspects (Table 3). These factors have objective and subjective aspects. The spectrum of the landscape approach factors from the functional area to the semantic area can be seen in Fig. 4. In this range, the more objective aspect of the factors, the more the factor approaches the functional axis, and the more subjective the factor, the more the factor approaches

Table 3. The triple aspects of landscape and their criteria. Source: Authors.

Landscape		
Meaning	**Aesthetics**	**Functional**
Sensory Richness and Identity Sense of Belonging and Memorability Pleasant and Attractive Sense of Time, Movement and Activity Vitality and Public Participation Sense or Place and Public Experience	Visual character Integration and Visual arrangement Proportions, Form and Size	Legibility, Transparenc and Navigation Safety and Security Permeability, Hierarchy, and Enclosure Mixed land use Inclusiveness Environmental comfort Public area organization Flexibility

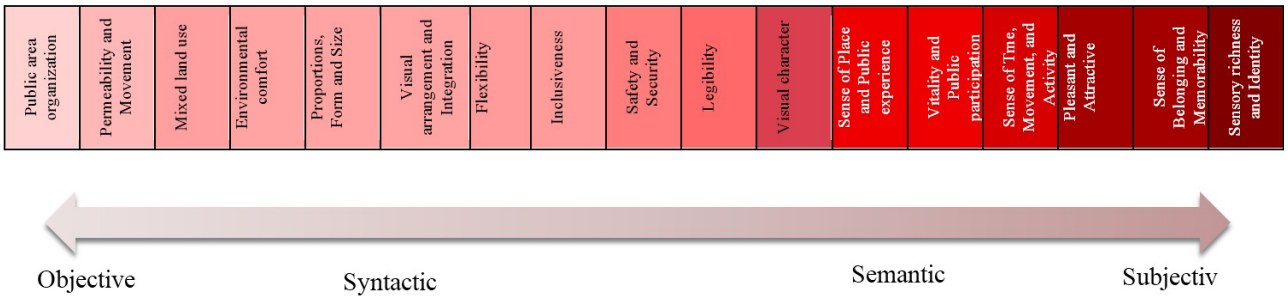

Fig. 4. The conceptual spectrum of some of the landscape approach factors from functional area to the semantic area. Source: Authors.

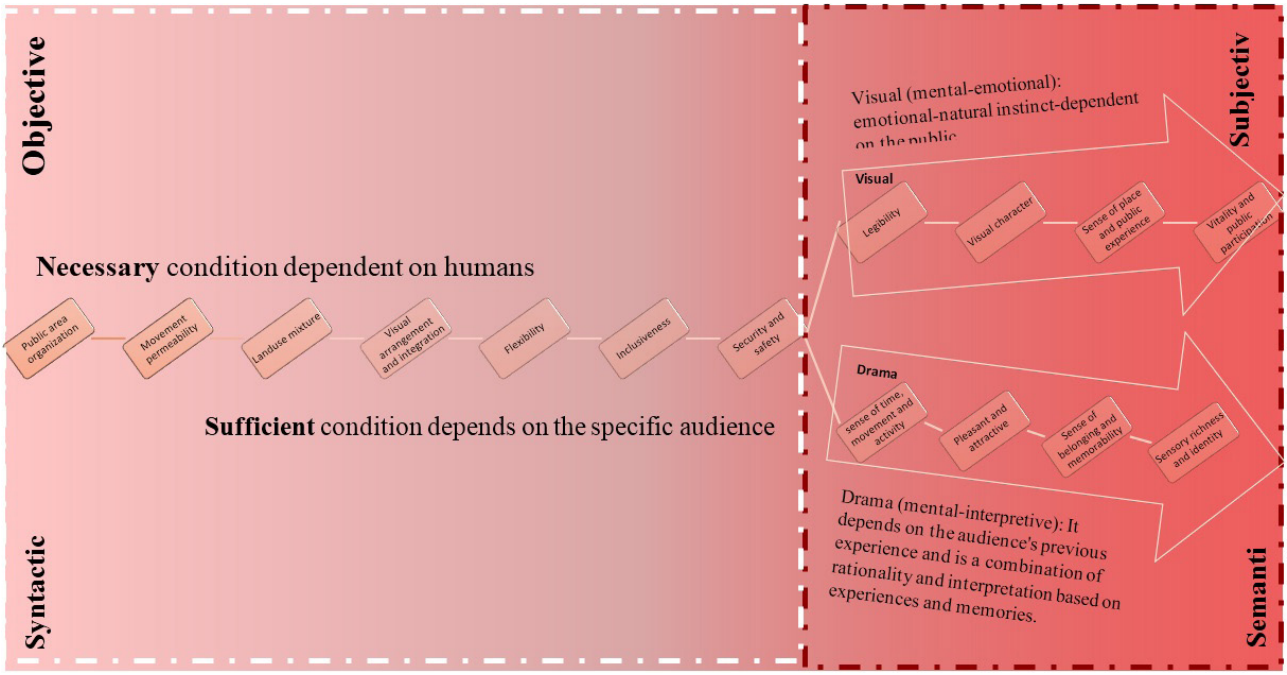

Fig. 5. The conceptual model of the spectrum of some of the landscape approach factors from objective area to the subjective area. Source: Authors.

the semantic range. To explain the criteria and indicators of the landscape approach used in the analysis, it is possible to first classify qualitative concepts in such a way that the criteria of the landscape approach are specifically separated. It makes it easier to define the specific criteria and indicators of the landscape. Semantic factors whose mental dimension is prominent, as mentioned, are divided into two categories of mental concepts - visual and mental - drama. "Visual" or "classical" concepts do not require previous experience and are understood by sensory exposure to the space physique and objectivity. In contrast, drama concepts are time-dependent and require prior experience, and t its meaning is understood with the help of reason and the connection between scattered perceptions. What appears in the mind as a mental memory needs matter and objectivity on the outside. However, it is not objectivity that plays a role, but objectivity is a tool for the association of mental memory. Therefore, "visual" concepts are understandable to the public, and drama concepts can be interpreted for a specific audience. Physical concepts are innate, natural, and dependent on the senses and emotions. However, drama concepts belong to the category of semantic items, which depend on the audience's experience and the rational combination (Fig. 5).

Discussion

The core of the space syntax theory is based on the dividing space by the systematic graphic concepts. Graphic concepts are divided into maps and graph diagrams. The maps are based on the convex space and the natural movement theory. These maps can be easily drawn as a simple graph. The software of various space syntax facilitates the investigation of the graph precisely. Therefore, the information analysis of the graph is possible by the graph's basic concepts, such as connectivity, depth, and distance. In the meantime, the landscape is both an objective and subjective phenomenon. The landscape's objective and physical factors can be studied using this method due to their syntactic feature. The more semantic and subjective are the factors, the less their syntactic dependency becomes; thus, the space syntax becomes more inefficient. However, space syntax deficiency does not include all the semantic factors in studying the landscape approach factors. The semantic factors that approach the visual-mental axis are interpretable by the functional aspects of human (activity). Therefore, space syntax can still be practical. The emotional-mental-objective spectrum factors are the necessary conditions for the desired landscape space that can be investigated syntactically. Nevertheless, the desirability of the space is based on inferential- mental factors. These factors are sufficient conditions and desirability criteria. For instance, two spaces with the primary and necessary factors are ideal in terms of security, legibility, and vitality. However, space desirability is considered. As a result, creating inferential-mental factors is raised. The necessary and sufficient condition for the desirability of the landscape depends on the audience and physique. For instance, in investigating the memorable space, we notice that this is a relative factor and cannot be investigated by the syntactic analysis of the space configuration that considers the human separated from the physique. Therefore, the syntax system has the necessary conditions to analyze the landscape approach but is inefficient in sufficient conditions.

Conclusion

Recognizing the landscape features depends on two factors. The first factor is the physical space features (Objective), and the second factor is the people's perception (subjective). The mental factor is as visual and drama. When we state that landscape is subjective-objective, it means that objectivity and subjectivity are inseparable and together in a unified whole. Hillier's space syntax model can evaluate the landscape. As concluded from the analyses, the space syntax has a syntactic feature through which it can evaluate the syntactic aspects (Objective) and semantic aspects (subjective) of the landscape. The more the factors of the landscape approach have physical and objective dependencies, the more precise the function of the space syntax. According to this graph, which is the main tool for the space syntax to analyze, the objective physical factors of the landscape are syntactically analyzed and can be easily investigated. In the meantime, some of the landscape semantic factors are the emotional-subjective and visual factors that can be syntactically investigated due to their physical aspect. Some of the semantic factors can be investigated in this method by evaluating human activity. The activity evaluation is implemented by measuring the material and syntactic features of the space. Another semantic aspect is inferential-subjective and drama factors. These strong subjective factors have a few physical dependencies and are more based on subjective memory and previous experience. Therefore, the syntax method cannot be applied for the factors in which the role of the human mind is more (interpretation and drama). Also, these factors are significant because the human and space desirability are made of the subjective-inferential or drama factors that the human tends to select more. The landscape orientation can be used to compensate for the lack of space syntax function. To this end, landscape considers the subjectivity and objectivity together. On the other hand, space syntax takes into account the human and space separately. In the space syntax, the

objective body and the audience's subjectivity are an integral whole using landscape orientation. Therefore, the context and human behavior become an integral whole, thus, all the syntactic and semantic dimensions can be investigated. As the graph is the main concept of space syntax, space syntax considers the intrinsic features of space's physique. However, it ignores the psychological and mental features and desirable and qualitative factors. Therefore, this method is not practical for the landscape. Suppose a relationship is established between the landscape's definition from space and syntactic space models, and the semantic factors are added to the space syntax model as the value-added in future studies. In that case, it will be possible to create a specific model for the landscape to recognize the space nature and intervene in that.

Endnote

* This article is taken from the Ph.D. thesis of "Saba Sultan Qurraie" entitled "Explaining the nature of the landscape using the space syntax" which was supervised by Dr. "Seyed Amir Mansouri" and Dr. "Maryam Singery" in 2021 in the Faculty of Art and Architecture of Islamic Azad University, Tabriz Branch has been completed.

1.Space Syntax: syntax is like investigating a word inside a text and its relationship with other words. Therefore, syntax means investigating the relationship between each space unit with its adjacent units in a complex unit. The space syntax is also called space arrangement.

2. In the landscape's definition of space or the space landscape approach, the landscape approach is an adverb. When we say landscape approach, it means that it has both the delicacy of landscape and is in accordance with the theory and approach of the landscape.

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