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## Exploring the Conceptual Model for Evaluating the Coherence of Urban Physical Form and Structure and Explaining Its Principles

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### Abstract

**Problem statement:** Coherence as a necessary quality in the physical, social, and economic life of cities has been less attended by urban planners in modern times, to the extent that the scattering and deterioration of the urban fabrics, and in particular the existing metropolises, can be attributed to the lack of attention to this quality in the planning and design of modern cities. One of the main reasons for this is the lack of attention to the existence of different approaches to studying the form, the structure and the absence of an integrated approach and criteria and principles that can be used to assess the degree of coherent form and structure.

**Research aim and question:** Therefore, this research seeks to elaborate the principles for evaluating the coherence of the physical form and developing a conceptual model. In this regard, this research aims to answer the question of what are the common principles between different approaches and theories about the physical form, and how do these approaches define the coherent relationship between the elements of the form?

**Research method:** In this regard, this research has used a qualitative content analysis method to draw out the concepts of separated text data (by study approaches that relate to the coherence of form and structure), and Finally, this study achieved a theoretical model or framework by extracting the texts abstract levels which reflects the passive and repetitive patterns in the content. Conclusion: The results show that the three main elements of the form, including street, land use and building, play an important role in creating coherence, and the street is the most important element in the connection and linking of the other two elements. Also, the mix and diversity criteria in the land-use and the size criterion in the building are considered to be important criteria for measuring the coherence of the urban form. On the other hand, linking and integrating as the most important criterion for creating coherence, must be formed on the basis of two fundamental principles of scale and hierarchy, so that the elements of the form in different structural parts (center, main axis, and zone) are connected together in a coherent way.

**Keywords:** *Coherence, Form, Physical structure, City.*

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### Introduction

Different components of urban fabric like streets, shops, offices, houses, walking zones, green spaces, squares, parking, etc., connected to each other to create a successful, efficient, livable city. This

success depends on geometric coherence. Therefore, achieving geometric coherence through the form, which connects the elements of the city, is a prerequisite for the urban context. This essential quality that is discussed for all living cities was considered in the morphology of old cities and villages with different cultures around the world. But the rules of the new urban form, despite the fact that they seek to reduce the complexity and increase the connection, not only failed to lead to a coherent city but also provided the context for the dispersion and deterioration of the old and new fabrics of the cities. Studies concerning the physical form of the cities have shown that attention to the complexity of the relationship of components in their connection and linking has been paid (Salingaros, 1998, 2000, 2005, Alexander, 1986). In the meantime, the transformation of these complex relationships into equations that can describe the possibility of measuring and how to link and integrate is very difficult. The existence of different approaches and theories in this area that lead to the definition of different principles and criteria in assessing the coherence of the urban form and structure are among the main problems of identifying the integrated principles of coherent urban form. The principles and criteria which can be through it are determined the coherence of urban form and structure. Recent studies have focused on the goals, method and general principles of coherence in different approaches (Tavalaee, 2007). None of these, however, has introduced the criteria and principles through which the coherence of the urban form and structure can be assessed. So the present study seeks to identify these principles and criteria by the content analysis method. In this regard, relevant literature was widely examined and it was shown that coherence with different approaches and theories in relation to the urban form has different formal definitions and principles. Each of these approaches emphasizes a different aspect of the coherence and also, does not provide the theoretical and operational model still that can be used to assess the coherence of the urban physical form. . Hence, to achieve this goal,

the method of qualitative content analysis has been used. According to this method, dispersed textual data is drawn out of contextual concepts to gradually reach more abstract levels of the text, and ultimately, a conceptual model or framework that includes latent regimes and repetitive patterns in the text (In relation to the urban coherent form and structure) has been provided.

## Literature and Research Background

### The coherence of physical form

The term *Ensejam* in Persian is equivalent to the Latin term of Integration and Coherence. In the Webster, Longman, and Oxford dictionaries, the term *integration* is more focused on the linking of two or more separate things, as well as on the operation or process of the linking of independent components, so that they work effectively together, but *Ensejam* with the equivalent of coherence implies a consistent, logical, and unifying state of the link, so that it is easy to understand something like a text because of the literal and logical connection of the different parts. Also, the link between the various, relevant, and valuable elements must be made in a systematic, logical or consistent manner. Therefore, the conceptual difference between these two words can be described as the “state and the quality of the linking” and “linking”.

The physical urban form, according to Conzen, and most morphologists, is composed of three elements i.e., streets, uses and buildings (Conzen, 2004). In addition to emphasizing the three elements mentioned as “fundamental elements of the physical form”, Kropf believes in the existence of a hierarchical structure in the composition of the elements based on the relation to the whole. He states that the way of linking elements in the formation of a coherent whole is the main goal of the physical urban form (Kropf, 2014: 52).

The concept of coherence in the literature of urban design, and in particular the physical urban form, generally means “the process of organizing the space order that links separated space” and, in other words,

“It’s created in space by integrating separated units of the form (elements of form)“(Tavalaee, 2007:25). Accordingly, in different kinds of literature and approaches, this concept based on other terms such as integration (Hillier, 1996, Hillier et al, 1993, 2000), unity (Ardalan & Bakhtiar, 1973), organization (Alexander 2002), wholeness (Alexander 1964), Structured (Bacon, 1976, Lynch 1960, 1958) used together or synonymously, which briefly discusses the background of this concept and its related approaches.

### **Approaches and theories related to the coherence of physical urban form**

Since the method of linking and the process of organizing the components of the city in different interpretations of this concept is different, approaches and theories have been formed on the study of urban coherence, approaches such as holism, organismic and structuralism, contextualism and aestheticism, each of which has defined the way to achieve coherence in accordance with its principles, which all of them emphasize the linkage of components (Tavalaee, 2007). Since the coherence is the linking of separated units in space, in this study avoided the approaches that study the urban components without regard to the wholeness. Accordingly, three approaches (holism, organismic, structuralism) and five theories, linking (in the form of structuralism approach), evolution (in the form of organismic approach), space syntax (in the form of structuralism approach), figure-ground and complexity are the most important approaches and theories that in this research are used to identify the principles of coherence.

**Coherence in the Holistic holism Approach:** The concept of coherence in this approach is formed based on “universe as a whole”. In this approach, the realm of cognition deals with the unity of the whole and not its components, and the phenomena are known through coherence and linking with other phenomena. The concept of coherence is explained by the distinction between the whole concept of the

collection. In this regard, Alexander states coherence as the necessary condition for the achievement of wholeness, he proposes coherence along with words such as good fitness, wholeness, order, and living structure. It also suggests that the degree of internal coherence of an ensemble depends on a whole net of fitting of form and context. In a perfectly coherent ensemble, we should expect two halves of every possible division of the ensemble (form and ground) to fit one another (Alexander, 1986)

**Coherence in the organismic Approach:** Generally, the organismic approach can be considered as a subset or as a Holistic approach, with the difference that the organismic approach fits the whole organic one. The lexical definition of the Organism is integrated part of the whole, the linking or the harmony of the components in the whole and organized physical structure. The four words are used for the concept of coherence in an organismic approach, the purposeful unity, contradiction, diversity, and suitability, which means, in the sense of consistency with the purpose, the combination of various elements that causes diversity (varied forms), proportionality and compatibility with each other. The original word, the purposeful unity, includes all of these, and the purpose is to reconcile and match the diversity and contradictions (Alberti, 1991). Therefore, coherence in this approach, as in the Holistic approach, refers to the inseparable trait of the organism word, for this reason, coherence is aligned with purposeful unity and order which the condition for achieving it in urbanization is fitness, diversity, balance, and harmony between components (Unity and plurality). Also, Marshall (2009) believes in three types of order, systematic order, index order, and functional order. He believes that the combination of these three orders will evolve the urban form and interpret the integration and coherence. He can see the order in the “street grammar” (between buildings, roads, and plots) as a systematic order, in the sense that these rules are more or less consistent and systematic in all ways, parts of land and buildings. In other words, the order of the elements in the form, most notably

the street, is introduced by the systematic order. But the index order is the rules and relations between the elements which irrespective of the shape and form, influence the formation of the structure of an urban area.. In fact, the central effect and the presence of centers and sub-centers can be regarded as another order, which may be called the index order. The third type of order, which in combination with two other orders leads to evolution and coherence, is a functional order. In this order, the function and activity are added to form and lead to the evolution of the urban form (Marshall, 2009).

**Coherence in the Structuralist Approach:** Objective structuralists believe that urbanization should be of interest to the spatial network as the connecting element of the city's body, and avoid focusing solely on building masses and facades. The spatial structure of the city, if it is designed on a macro scale, can create the urban form coherence. The designer can link the main buildings with the design of the main roads, in general, creates unity and integrates the city. In Bacon's view, the form of the city should follow its spatial structure, which is the main organizing force (Bacon, 1986). Subjective structuralists point to the interference of the mind in the city's perception and believe that perception, without considering the movement, cannot be understood. Accordingly, Bacon believes that the creation of harmonious experiments while moving in space is effective in creating an integrated and coherent image, and Lynch (1960) makes this harmonious experience, which results in an intelligible mental image, possible through a coherent body collection. Accordingly, structuralist conveys coherence through "connectivity" in the objective structure, and "continuous mental image and intelligibility" in the mental structure, which combines these two structures to create a coherent whole.

**Coherence in figure-ground theory:** This theory studies the relationship between buildings as a solid mass (figure) and open spaces (ground). The purpose of these measures is to reveal the structure of urban spaces in the city or region, which, through

the creation of a hierarchy of spaces of various sizes, gives rise to a coherent whole. According to Trancik, to avoid the formation of undefined and separated spaces, what most should be considered in the design of urban spaces is the design of a set of open outer spaces that are defined within a coherent whole (Trancik, 1986: 99). Finally, according to Trancik, the most important issue in the figure-ground theory is the organization of the relationship between mass and space. If the link and the ratio between mass and space are complete and understandable, the spatial network is successful; components, in linking with each other and within the coherent framework, create a unique personality for the region; but if the relationship between mass and space is not balanced, components of them are separated and out of the framework, which is the result of a space that is lost and disconnected.

**Coherence in Complexity theory:** Michael Batty in his book *Cities and Complexity* collects a broad spectrum of perspectives on complexity and urbanization, and suggests using models and methods to explore this area. In this regard, he states that "this philosophy is that cities must be treated in the same way as basic structures that are built up from the bottom up, the process of making them intrinsically combined, and eventually shaping them", and leads to structures that are distinguished as a hierarchy from each other. Batty has explicitly identified the theory of complexity as a "new paradigm" (Batty, 2005). In this regard, Salingaros considers the complexity necessary for coherence and believes that the geometrical assembly of elements to achieve coherence results in a definite and identifiable urban morphology, and for this reason, the rules of the new urban form, which reduce connection and complexity, could not lead to urban coherence. He also emphasizes that a coherent city form must also be plastic; i.e., able to follow the bending, extension, and compression of paths without tearing. In order to do this, the urban fabric must be strongly connected on the smallest scale, and loosely connected to the largest scale. Connectivity on all scales thus leads

to urban coherence (Salingaros, 2000). Therefore, complexity theory calls for the achievement of coherence as the connecting and linking of elements of a city based on the network hierarchy, and the basis of this link is in the repetition of the hierarchy of the scales. Accordingly, the fractal geometry method is proposed to solve complex and achieve coherence. Therefore, what is seen in the literature of studies on the coherence of the physical form is the existence of different approaches, theories and perspectives, which any of them is based on a principle of coherence, including consistency, fitness, hierarchy, connection, and linking or just on a special element of the form (street, or activity or mass), and do not explicitly define the form of coherence, the way of linking and integrating these elements in terms of achieving coherence, which is indispensable and necessary in evaluating the coherence of the physical form. Accordingly, the present paper has been used Content Analysis method to achieve a conceptual model for assessing the urban physical form coherence to derive the coherence principles and criteria and relationships between urban form elements. The following is an explanation of this method and its results.

### Methodology

The present study seeks to identify the criteria and principles for measuring the coherence of urban physical form and to develop a conceptual model for the relationship between the elements of the form. Therefore, the Content Analysis method has been used to extract these principles and relationships from related texts. . So, in order to achieve a theoretical model or framework that extracts the latent rules and repetitive patterns, the following steps are followed. As explained below:

- A) Data gathering (analysis units, sampling units, report)
- B) Grouping and Categorization data
- C) Abstraction
- D) Reporting the analyzing process and the results (developing a theoretical model for the evaluation of

the coherence of urban physical form (Krippendorff, 2004).

#### A) Data gathering (units, sampling units, report)

Units: The first step in any research with content analysis method is to determine what is to be viewed, or studied, and recorded, and then considered data. The units of analysis are determined according to the research objectives and related techniques. In content analysis, there are three types of units: sampling units, record units and text units.

**Sampling units** are parts of the observed reality or the linguistic flow of the source of the research, which is independent of each other (Krippendorff, 2004:74). Based on the results obtained in the previous section, there are different approaches and theories in relation to coherence, (each of which refers to a specific criterion for achieving it, such as, order, structure, wholeness and ...) and also because of the lack of comprehensive principles and criteria that the coherence of urban physical form can be determined on the basis of it, to extract the principles and rules governing the coherence and the construction of its theoretical model, each of the approaches is selected as a sampling unit, that based on each sampling unit, the sample size is specified. Therefore, holism, structuralism, and organismic approaches, which are the most important approaches to defining the coherence of the urban physical form of cities, were selected as sampling units. Also, theories that are independent of the approaches proposed to discuss coherence are also considered. These theories include theories of figure-ground and complexity theory.

**Record units** are parts of the sampling unit that can be separately analyzed. Since sampling units are usually large, rich, and more complicated than the text unit can be considered, record units must be identified. These units are a specific part of the content, which are described in terms of their place in a certain category. (Ibid). Since the purpose of this study is to extract the criteria for evaluating the coherence of urban physical form, an overview of the views, schools and approaches related to the form of

the city was identified as three important elements in the analysis of the physical form of cities, streets, land use and masses (urban buildings and blocks). Thus, the record units in this research include the elements of the physical form such as street, land use and the mass (building and block).

**Text units** determine the text information that can be used to describe the recording unit. “The text units identify the part of the text that is required to describe the record units. Text units do not require that they

are independent or can be described separately, they can be overlapping and include multiple record units” (Ibid, 76). Therefore, the text units in this research include describing each element of the form in order to achieve coherence and the relationship between them. In other words, this research will describe the state of any record unit that will lead to the coherence of urban form.

Table 1. Analysis units. Source: authors, 2018.

Analysis unit	properties
Data units	Books, Articles
Sampling units	Holism, structuralism, organismic approaches and figure-ground and complexity theories
Record units	Street, land use, mass (building and block)
Text units	Describe the characteristics of each record unit and the relationships between them in achieving coherence

**Determining the sample size:** After determining the sampling method, the next step is determining the sample size. Krippendorff (2004) believes that there is no consistent response to determine the sample size and states, when the sampling units have the internal consistency, one sample is satisfactory for each sampling unit. However, to suit the sample size, the sample should be divided into two equal parts. If both sections confirm the same statistical results and the same level of assurance, Sample size can be considered appropriate. Therefore, the sampling units and the resources used in each unit of sampling, according to Table 2, consist of 5 units and 35 samples, each of which at least one source has been investigated and adapted to change the content of resources, new resources of each unit was added. In the validity and reliability of the data, some equal randomized samples were taken. The results show that in the same randomized, there is the same frequency and more than 95% of the total frequency are repeated with the same criterion. (table2).

**B) Grouping and Categorization data**

After identifying the analysis units, the data must be categorized and reduced in order to make the coding more convenient. Accordingly, the present study has categorized the content according to the record units. The most important principle of the categories is that they should reflect on the researcher’s research problem. This means that the analyst must clearly define the variables that it deals with (form elements), and, on the other hand, they must specify the indicators that the content information is placed on the basis of each category. As already mentioned, street, land use and mass (building and block) are elements that define text units, and each source with a specific sampling unit expresses how to achieve coherence on the basis of each element. Some sources emphasize an element, some refer to two and some to all three elements, and even some sources of the relationship between these elements have been analyzed. Therefore, in addition to categorizing the features listed for each element of the form, their relationships should also be considered in coding. Each description defines how the form elements

are achieved through the coherence. Based on these definitions, coding is carried out that these codes specify indicators and principles for achieving coherence. So that codes can reduce common meanings and descriptions, and ultimately, they can be used for criterions and indicators of coherence. Table 3 shows the way of categorizing the record and text units. Further, according to the article’s limitations, from a total of 35 tables (proportional to the sample size), only one table

(one example) is used to determine how to categorize and coding is done (Table 4). It is worth noting that the results and data extraction were based on the frequency of all 35 samples(table3).

**Abstraction analysis**

Based on the content analysis method, the frequency estimation method has been used in the samples to derive the principles and criteria for the evaluation

Table 2. sampling units and sample size. Source: authors, 2018.

Sampling units	Sample size	Sample
Structuralist approach	10	Bacon 1986, Hillier et al 1993, Hillier, 1996, 1996, Tibbalds 2001, Roger Trancik 1986, Remy Allen 2004, Pamir 2004, Leslie Martin 1972, Lynch (1960 and 1958), Marion Roberts-Clara Greed 2001
Organismic approach	8	Alexander (1964, 2002), Oliveira 2013, Bahreyni 2011, Jane Jacobs 1961, Stephen Marshall 2009, Ardalan & Bakhtiar 1973, Ahari 2012
Holistic approach	9	Ardalan & Bakhtiar 1973, Alexander 1987, Ernest Sternberg 2000, Tavassoli 2007, Tibbalds 2001, Habibi & Ahari 2012, Tavalae 2007, Golkar 2014, Roger Evans 2007
Complexity theory	4	Batty 2001, Salingeros (2000, 2005, 1998)
Figure-ground theory	4	Trancik 1986, Alexander 1964, Douglas Kelbaugh 2002, Richard Hudman 1960
Sum total	35	

Table 3. Categorization and classification of sample units. Source: authors, 2018.

Sampling unit	sample	Record units	Text unit	Categorization and classification of text units			
				Category 1	Category 2	Category 3	Category 4
Approaches and theories related to coherence	A book or article related to theorists related to any approach or theory	Variables or form elements Street, land ) (use, mass	Description of record units Describing the ) characteristics of the elements and their relationship to achieve a coherent (whole	Principles of coherence in each element of the urban physical form	How to analyze elements	Identify the position of elements in their structure and context in coherent form analysis	Criteria for combining elements to achieve coherence
				Principles of the internal coherence of each element separately	Which is presented as a single element or in combination with other elements	Includes fabric, center and main axis	How to connect and link elements based on the coherence principle

Table 4. Classification of data in order to achieve the principles and criteria for the coherent form. Source: authors, 2018.

Sample units	sample	Textual and descriptive units			Category 1			Category 2			Category 3			Category 4
		street	Land use	mass	street	Land use	mass	street	Land use	mass	street	Land use	mass	Criteria for combining elements to achieve coherence
Approach or theory	theorists	Characteristics of elements and their relationships in order to achieve a coherent whole			The Criteria of Coherence of the element of urban form			How to analyze elements			Identify the position of elements in their structure and context in coherent form analysis			Emphasize the scale in composition
		Connections are established only between complementary centers. There is no reason to link communication between the same sites in terms of function. The life of a city derives from the degree of connectivity it stems from the geometry of a city, it is to provide a connected and integrated network.			Connecting and integrating			combinatorial			center			
		The ratio between the size or capacity of an element or its position in the hierarchy of the set of elements and its number in the reciprocal set, which means a large number of small-scale connections versus a small number of large-scale connections in a collection or size distribution by inverse force method			Connecting and integrating			Single element			fabric			
		The general idea of {fractal being} is the existence of a hierarchical structure that has both connectivity and integrating on all scales from very large to very small			Connecting and integrating			combinatorial			fabric			
Salingeros	complexity	In a fractal element, the scale is an operating and pivotal determinant, so that the nature of a fractal is defined by the existence of a certain rule on different scales			proportion dimensions and size			combinatorial			combinatorial			Emphasize the scale in composition
					proportion dimensions and size			combinatorial			combinatorial			
					proportion dimensions and size			combinatorial			combinatorial			
					proportion dimensions and size			combinatorial			combinatorial			
					Connecting and integrating			combinatorial			combinatorial			Emphasis on hierarchy
					Connecting and integrating			combinatorial			combinatorial			
					Connecting and integrating			combinatorial			combinatorial			
					Connecting and integrating			combinatorial			combinatorial			

of coherence. Based on the categorization of the contents of the text units (four categories), the results are presented in four main sections and the compilation section as follows:

- A. Identification of principles for assessing coherence by divided to the physical form elements (category 1)
- B) How to analyze elements in studies on form coherence (category 2)
- C) Identification of the position of elements or their composition in the structure and context of the placement (category 3)
- D) Identification of the principal of coherence

evaluating in the combination of the elements of the urban physical form (category 4)

E) Explanation of the conceptual model and the criterions for evaluating the coherence of the urban physical form (conclusion)

**Identification of principles for assessing coherence by divided to the physical form elements**

As noted, Alexander considers the achieving condition to coherence, in addition to fitting the form with context, in the internal fitness of each element. According to the results, some studies have focused on the inner

coherence of each element of the form and some on the coherence of the relationship between the elements. Therefore, in addition to the criteria for the coherent composition of the elements, the internal coherence criteria of each element are examined according to the categories 1 in Tables 3 and 4, the results of which are shown in Table 5 below:

**Street:** The results on the basis of the 35 samples examined show that the principle of linking and integrating is the most important principle of coherence in the streets and streets network. It is important both in connecting and linking the paths and in combining and linking other elements (buildings and land use) to each other. Bacon (1986) suggests the intra-network connectivity and integrating as a reason to create consistent and continuous experiences in space, and Hiller et al. (1993) introduce this integration as a factor in increasing movement and enhancement of attractive activities. As the link and connection increase, the dispersal and disconnection will decrease, and the coherence and integration of the city will increase. The hierarchy as the second principle in creation of the coherence of the street network and the urban physical form identifies how to connect and link the

streets. Marshall (2009) believes that while there are many ways in connecting the various ways defined in different ways, there is only one way in which the paths tend to be linked together in a systematic and consistent way. Road networks often come in a hierarchical manner, that is, in the hierarchy of main roads, middle roads, and subsystems. These routes are often based on a range of more strategic ways to make up local (sub) ways. Other principles with a low number of repetitions are identified as no significant principles and standards relating to the coherence of the street(table5).

**Land use:** In the literature related to the form, some land use and activity are defined as the function of the form, and some are considered as the determining element of the form. In the discussion of the urban form coherence, land use is the key and considered element, because the coordination between the function of a building, a block, and a street is essential in creating coherence. Salingaros (2000) finds this coordination and coherence in the diversity of highly addictive (complimentary) elements on a similar scale from a single unit. Studies show that diversity and mixing are important as an important criterion of coherence. Marshall (2009) believes

Table 5.the principles of coherence evaluating that divided to each element of urban physical form. Source: authors, 2018.

The principles of coherent street	the coding analysis in the definition of streets as a coherent element		The principles of coherent land use	the coding analysis in the definition of land use as a coherent element		The principles of coherent mass	the coding analysis in the definition of mass as a coherent element	
	frequency	percent		frequency	percent		frequency	Percent
Linking & integrating	16	53.33%	Diversity and mixing	9	69.23%	the proportion of dimensions and size	4	57.51%
hierarchy	10	33.33%	Fitness & balanced distribution	4	15.38%	Continuity & cohesion	3	42.86%
scale	3	10%						
Diversity and mixing	1	3.33%						
total	30	100%		13	100%		100%	

that a variety of habitats with a small combination has a great attraction if any activity has its own proper scale. Therefore, to identify coherent identity environments, we need to be able to identify this diversity and differences (Tibbalds, 2001).

After mixing and diversity, fitness and balanced distribution are in the second place. Various studies show that the distribution of diverse land use depends on their functional scale and their location based on the hierarchy defined in the urban structure will be necessary and improve urban coherence. In the discussion of land use distribution in connection with coherence, Salingeros (2000: 10) refers to the distribution of size and interdependence, and believes that “the ratio between the size or capacity of an element and its position in the hierarchy of the elements sent and its number in the set should be inverse”. In related to fitness of land use, there are two types of fitness, the first compatibility between land use with each other and the second is the fitness between the scales of land use with its functional scale. Alexander (1986) defines “Fitness” as the relationship between activity and other elements of the form or field of activity deployment. . Compatibility between activities as well as other elements returns to scale. Thus Salingeros (2005) introduces the scale as the most fundamental principle in the definition of coherence.

Mass and building: Usually approaches and schools such as the French and Italian schools emphasize the building and fabric of the building, and the British school on the block and parcel. Therefore, based on different approaches, this research to cover all parts of the mass physical form (including building, parcel, and block) has been attended to all parts of mass in each sample. The proportion of dimensions and size are the important factors in linking between mass and other elements if the connection and linking defined base on the coordination between the scale of mass with street and land use scale in a defined hierarchy, it can lead to form coherence. In this regard, Trancik states that to solve the dissociation of urban physical and spatial structure, designers should avoid paying

attention to building construction and should use the mass and the building to determine the proper location of the outer space which, through the creation of a hierarchy of spaces of varying sizes, can form a coherent whole (Trancik, 1986: 101-103). In connecting and linking the mass with other elements, literature emphasized the positive and negative space connection, which indicates the relation between mass and space. In this regard, the tiny parcel is a factor for creating the coherence, in which space considered as a means for disintegrating the city unless the sequence created between the public and semi-public and private space. Therefore, discrete and discontinuous spaces that impede this sequence must be minimized or eliminated.

### **How to analyze elements in studies on form coherence**

Studies related to the coherent form show that scientists and theorists in this field deal with the coherence of form, more than 77% of them emphasize the composition of elements in the analysis of form coherence, some of which combine three elements and some combine two elements and only 33% of them have defined the coherence of the form based on the inner coherence of an element.

In this analysis, the street is considered as the most important element of the form mentioned in the preceding section, and more than two other elements are analyzed individually, which indicates the importance of its role in form coherence. Also, the mass (building and block) is more in combination with other elements than individuality, which indicates the dependence of this element on the function and the manner in which it is connected and combined with space in the analysis of coherence. Land use has been considered in relation to the other two elements in total (individual and combination) less than two elements in relation to the coherent form and more are defined in the role of compatibility of mass and space and their function (Table6).

### Identification of the position of elements or their composition in the structure and context of the placement (category 3)

Since that determinant factor of urban form and the relationship between its components is the main urban structure, so the urban form is extensively affected by the urban structure (Daneshpour & Rousta, 2012, 53). On the other hand, the urban structure composed of a spine and an interconnected

web of diverse land-use and elements that bring together the city in its entirety. Accordingly, the components of the structure, which include the most important streets, centers, and zones, are considered as a context in the combination of the urban form elements. Therefore, the content of texts has been categorized base on the urban structure components (axes, nodes, and polygons). (third category).

Table 6. How to analyze elements in studies on form coherence that divided to each element of urban physical form. Source: authors, 2018.

How to analyze elements related to the coherence of form	Frequency of Street	The frequency of land use	Frequency of mass	Sum total	percent
emphasis on combination of each element with other elements in the analysis of coherence	47	52	65	164	77%
emphasis on the inner coherence of each element	30	13	7	50	33%
<b>Total</b>	<b>77</b>	<b>65</b>	<b>72</b>	<b>214</b>	<b>100%</b>

### Identification of the principles of coherence evaluating in the combination of the elements of the urban physical form (category 4)

In the combination of the urban form elements, in order to achieve coherence, some studies ignored the context that the elements placed but some of them considered the physical urban structure as the context in the urban form analysis and the linking way of each element with other elements defined in zone, centers, and main streets. Fabrics (zone or polygon) as the set of three elements of street, land use and mass, are most emphasized among other structural components. After that, the centers (nodes) considered in the discussion of coherence and finally, main streets (main axes and edges) are which have same criteria with centers in most studies. The results according to Table 7 show that scale and hierarchy are the most important criteria for connection and linkage and compatibility between elements. These two criteria generally have the most emphasis on fabric, which shows the entirety of form

in urban units. Also, the criteria for combinations of mass, street, and land use, in the centers and main axes for achieving coherence are specified in Table 7 (Category 4).

**Scale:** In the elements combination (street, land use, mass), scale plays an important role. In most studies, the combination of the three elements of the urban physical form in order to achieve coherence is referred to scale as an important and central factor. The scale is used to compare the collection of dimensions and proportions with other sets and it is a concept that contributes to the consistency between the components of the city (Smith, 1977). Tavasoli (1990) raises the principle of scale and fit as an organizing principle, and relates the scale to the relationship between the size of an object space and the surrounding space, and believes that the relationship between the various dimensions of a space or the element is independent of size. Therefore, the scale is one of the most important criteria for the relationship between elements and

their fit for achieving coherence. Salingaros (2005) also considers the scale as a determining factor in urban coherence, and he believes that many urban problems are related to scale. In this regard, it is necessary for the city to be linked and connected in all its dimensions. The connections that operate on different scales vary with each other (Salingaros, 2005).

The purpose of the scale in this study is the functional scale of each element in relation to other elements. In other words, in the placement of each element along with other elements, their functional scale must be compatible (for example, crossing a non-local street from one neighborhood causes a separation and loss of coherence in fabric and structure)(Table7)

**Hierarchy:** Different theorists point to the principle of combinatorial hierarchy, in the combination of urban physical form element (Alexander, 2002, Salingaros, 2000). They show that the relationship between elements in a structure can be defined. There is a general agreement that the elements have a hierarchical relationship with each other. (Kropf, 2014). Studies show that a simple combinatorial hierarchy has to move towards a coherent mix of buildings, area, and streets; what that Kropf defines as the main goal of analyzing the urban physical form. (Kropf, 2014). Therefore, the hierarchy is important as the controller of scale changes in the composition of urban form elements, which has been considered in formulating a coherent form evaluation model.

Table 7. Principles of coherence evaluating in the combination of the elements on the placement of context (Fabric, center, main ax). Source: authors, 2018.

Principles of coherence assessment based on the composition of elements	Physical structure components as the context for combining the urban form elements			frequency
	Fabric (polygon)	Center (Node)	Main ax	
Combination based on the scale	74	6	7	87
Combination based on hierarchy	16	8	2	26
Increase of linking and connecting	5	6	1	12
Increase of mixing and diversity	1	8	2	11
Increase of small parcels	1	7	1	9
Increase of the betweenness index in the main axes between centers			6	6
Increase of density		3	3	6
continuity and integrating of elements	3		1	4
Compatibility between elements	3			3
total	<b>103</b>	<b>38</b>	<b>23</b>	<b>164</b>

**Explanation of the conceptual model and the principles for evaluating the coherence of the urban physical form**

The conceptual model of the coherence evaluation of physical form that shown in figure 1, has been created based on the internal relationships of each element and in combination with other elements.. Since the principles for assessing the compatibility between elements is “functional scale” and also, function and

the role of each element with other elements, in a hierarchy system, must be analyzed. Therefore, in addition to the syntax and configuration principles, the function of each element also must be considered. Therefore, in evaluating the coherence of the physical form according to Fig. 2, first the internal fitness of the elements and then the compatibility of the elements with each other in the form of the structural system (at the position of the fabric, center and main

axis) must be examined.

According to Fig. 1, for assessing the coherence of the urban physical form, it is essential that first, the inner relationships of each element according to their principles evaluated and then the binary and tripartite relations between elements analyzed in the defined structural point. . In other words, it is necessary to evaluate the compatibility between the elements in their connection in the different contexts (fabric, center, main axis) for evaluating the coherence of the form. It also recommended, that the base study units would be neighborhoods according to the framework that provided, because, in assessing the coherence, an urban unit should have the entirety of a structure, such as buildings, center, and main street, so that it can link the three elements. This unit can be

referred to the neighborhood in the smallest division (Smith,1977& Marshall, 2009).

### Conclusion

Previous studies, in relation with the concept of the coherence of the physical form, especially the urban physical form, generally define coherence as the “organizing process of space order that interconnects separate spatial units (elements)”, or define it as the result of combination of separate units (form elements) in space. The present research, with an emphasis on these concepts, has studied the approaches related to the coherent form and have proposed the principles and criteria and the relationship between urban form elements to operationalize assessing of the coherence (linking the three elements includes street, land-use,

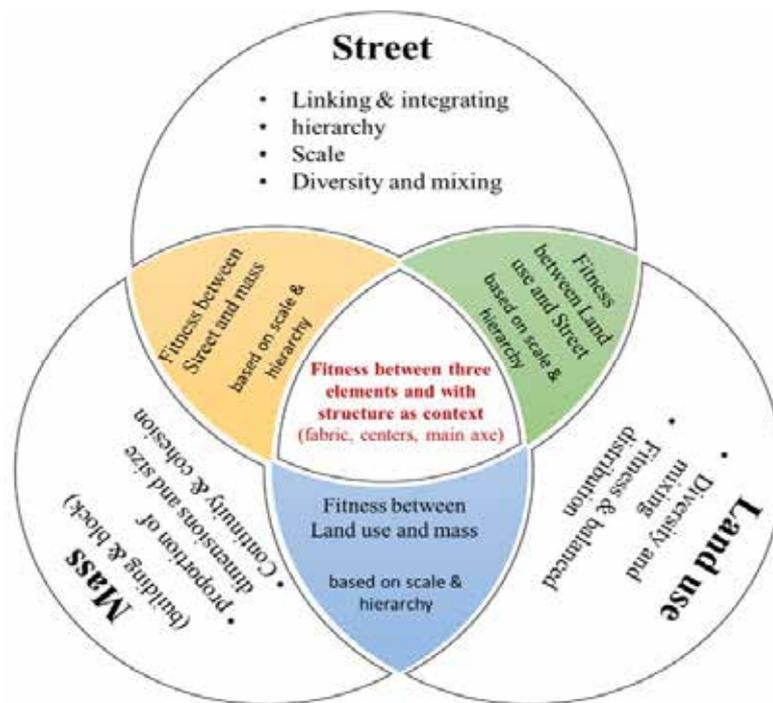


Fig.1. the conceptual model for evaluating the coherence of the urban physical form (The relationship between elements and stages of analysis from single elements to dual and triple combinations). Source: authors, 2018.

and zone that in the discussion of physical form coherence is noted). The present paper, based on the results obtained from the analysis of the content of related theories and approaches, determined that the

street is the most important element of the form and the main factor in the linking and connection of other elements. Also, two principles of scale and hierarchy were introduced as the most important principles of

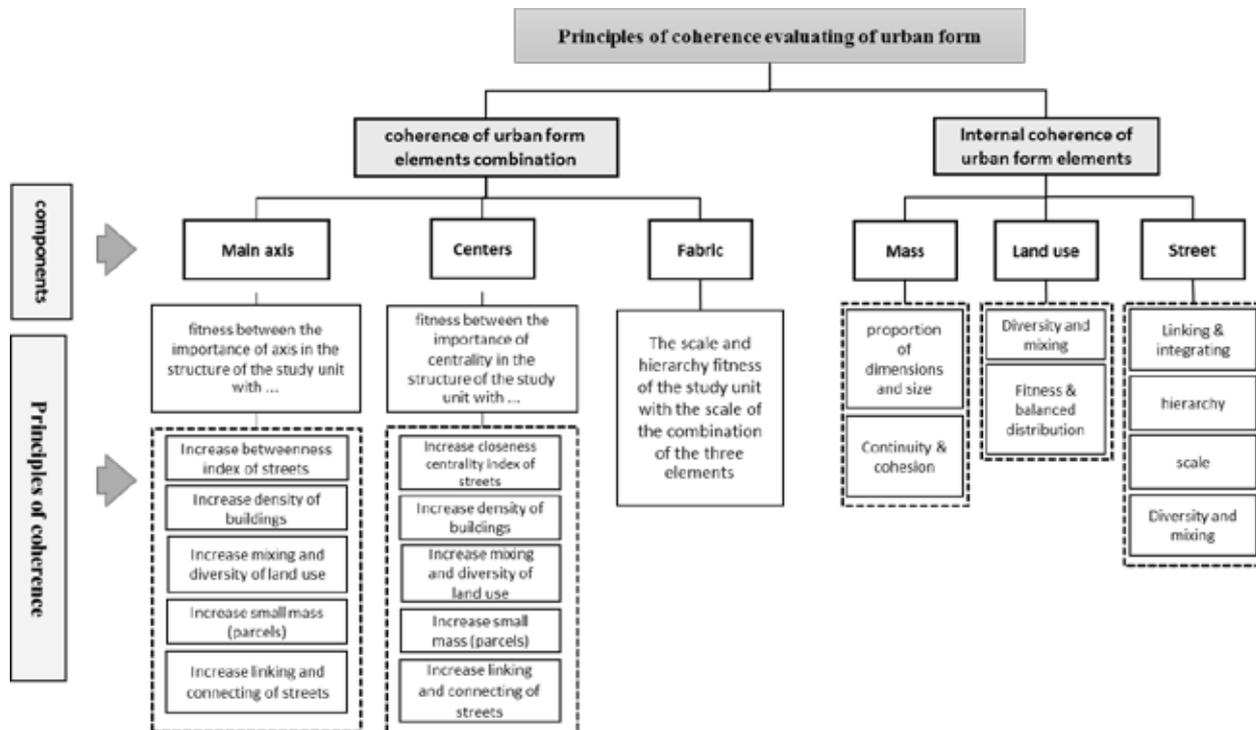


Fig. 2. Principles of coherence evaluating of urban form based on internal coherence and coherence of their composition. Source: authors, 2018.

linking and connecting elements in combination. Also, the relationships between urban form elements are different in the components of urban structure (centers, main streets, and zone), and the elements of the form in a different structural position have different relationships. Therefore, in evaluating the urban physical form coherence, the components of the structure should also be considered. Also, the compatibility of the scale and the hierarchy of elements in each study unit (neighborhood, district, district, and city) is important to be considered in evaluating the degree of coherence. Ultimately, what is important in evaluating the coherence of the urban physical form is the relationship between the elements, not the evaluation of the coherence of each element alone. For example, the integration of streets (in ways such as space syntax that Hiller poses) cannot determine the coherence of the form

and the urban physical structure alone. Therefore, in the conceptual model and the framework for the evaluation of coherence, the principles are distinguished by elements, as well as their relation to different structural situations, which is the most important achievement of this research.

Accordingly, in a clear answer to the questions of this research, it can be stated that this paper, in addition to explaining the principles for evaluating coherence, provides a conceptual framework and methodology for its operation. Also, in answering the question of how relationships between elements should be defined, it was discussed in the conceptual framework, which, based on this framework, could evaluate the coherence of the form and the urban physical structure, so this research paves the way for measuring and evaluating urban form coherence in future studies.

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