

Reflection on Quantitative and Qualitative Methods of Urban Form-Morphological Studies (Approaches and Techniques); Case Study: Historical Texture of Khorramabad*

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ABSTRACT

Comprehensive recognition of urban form will be an effective step in success of developing new urban plans. Since urban form-morphological analysis provides a more comprehensive view of the city for endogenous and exogenous urban development plans, the present study aims to review the studies on urban form, and classify them in terms of quantitative and qualitative methods, as well as to introduce their approaches and techniques. Therefore, a comprehensive classification of quantitative and qualitative studies on urban morphology, approaches and analysis techniques is presented by examining the intellectual evolution of theorists and emphasizing the theoretical foundations of recent scientists such as Moudon, Olivier, and Kropf. Then, in the conceptual framework of the research, which is developed based on the studies reviewed, the constructive elements are introduced and the constructive urban form-morphology relations are analyzed. Despite some historical monuments and its high potential to become a tourism-historical hub of the city, the Darb-e Babataher Neighborhood, located in the historical core of Khorramabad, faces a lack of attention to its physical-spatial values and qualities. The present study is applied research carried out using the mixed (quantitative and qualitative) method. The qualitative methods applied in the present study are exploratory studies and directed content analysis. This research extracts cognitive tools and analytical methods by classifying the urban form-morphological study approaches, presenting techniques appropriate to each approach and analyzing the content of its ideas. The Urban Network Analysis (UNA) technique is used to analyze the case study and investigate the mobility in it using five «reach, gravity, betweenness, closeness, and straightness» functions in network analysis. Findings indicate that based on respect for the valuable space remained from the past, the character of urban neighborhoods in historical textures can be strengthened and consolidated by combining complementary design, endogenous development, and adaptive design while preserving the morphological elements and the main characteristics of the texture.

Keywords: Urban Form, Urban Morphology, Urban Texture, Khorramabad, Urban Network Analysis (UNA).

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1. PROBLEM STATEMENT

The most important visual aspect of the city is urban form. It has a direct impact on citizens' perception and legibility of the city. Due to various climatic, social, economic, political factors, and natural and unnatural disasters, the urban form can experience fundamental changes over time. Recognition of urban form, decision-making, and intervention policies will improve the quality of citizens' life if they are appropriate for recognizing and analyzing the city formation process. Urban morphology is the science of studying the physical shape of cities. In addition to the form and appearance, it also deals with the internal organization and space syntax of city components. Given different definitions for the concepts of urban form and urban morphology, various theories and a variety of techniques studied for the analysis of urban form by researchers, the present study aims to classify the urban form-morphological studies in terms of quantitative and qualitative methods to facilitate the understanding of these studies, based on the four approaches proposed by Kropf by reviewing the approaches proposed by Anne Vernez Moudon (1994), Vitor Oliveira (2016), and Karl Kropf (2017). In the case of qualitative method, one can mention the historico-geographical and typomorphological approaches. In the case of quantitative method, one can mention the configurational approach with space syntax and urban network analysis, and the spatial analytical approach with cellular automata technique, fractal analysis, and spacemate technique. Cognitive tools, analytical methods, and analytical ideas are obtained through directed content analysis by reviewing the characteristics of each of the approaches abovementioned. This research focuses on the historical center of the city. The historical textures are precious works containing the culture and knowledge of urban planning and indigenous architecture of our country (Abad Boom Consulting Engineer of Qeshm, 2005). Despite its strategic location due to its proximity to historical uses, the Darb-e Babataher Neighborhood, located in the historical texture of Khorramabad, has been neglected as a place with high economic potential to attract national tourists. Its urban spaces and symbolic spatial network do not have the required legibility and coherence, causing the loss of physical cohesion of the texture and the lack of continuous mobility in the spaces of the neighborhood. In the last half-century, the Darb-e Babataher Neighborhood has been not considered by city officials, and consequently worn out, and exposed to destroy. Thus, it has been the settlement of poor urban people or immigrants (Part Consulting Engineers, 2015). Therefore, in the present study, the spatial mobility and formal urban structure of the Darb-e Babataher Neighborhood in the historical texture of Khorramabad are analyzed to improve urban form-morphology using the urban network analysis

technique, which is a part of the configurational approach and one of the quantitative studies. This study aims to introduce methods in the form of Kropf's classification (2019) to achieve a comprehensive method for studies on urban form-morphology by extracting «cognitive tools», «analytical methods» and «design ideas». Therefore, the research questions are: What are the cognitive tools, analytical methods, and design ideas in form-morphological studies throughout history? How can a more comprehensive analysis of the relationship between elements and components in the field of morphology be achieved? How is the Darb-e Babataher Neighborhood investigated using the urban network analysis technique?

2. BACKGROUND OF FORM-MORPHOLOGICAL STUDIES

The city form represents its physical identity and provides a better understanding of the urban reality of the place (Amni Mohamed, Zalina Harun, & Abdullah, 2018). Understanding the importance of urban morphology including the design and composition of the urban form and the effective processes in its formation helps urban designers to gain knowledge recognize local development patterns and transformation processes (Conzen, 1968). Conzen introduces land use, building structures, subdivision patterns, and connection networks as the key elements of the city form that are effective in defining the shape of the city in the morphological process (Carmona et al., 2003, p. 85). It includes three design elements: street, plot, and building (Kostof, 1991, p. 26). Division of an area into morphological areas or urban landscape units is the culmination of the exploration of the physical development of an urban area for Conzen (Whitehand, 2001). "Brenda Case Scheer" introduces a space-time model, which is used by environmental scientists, to better understand the relationships between the main elements constituting the shape of a city. Her model includes land, structure, plot, building, and objects (Scheer, 2003, p. 30). A morphological region is an area whose constituent units have a specific shape that distinguishes it from other surrounding regions (Oliveira, 2016). In any approach, the urban block can be used as a basic morphological element in general analyses because as a backbone, it communicates and performs formal planning of settlement simultaneously (Amni Mohamed, Zalina Harun, & Abdullah, 2018). Urban morphology, as a mediator of political conflicts and the politics of spatial knowledge in social actions, is beyond the transformations of place according to Kim Dovey's research (Dovey & Ristic, 2016). The morphology of public space networks affects the permeability and walkability of public spaces and acts as a mediator (Pafka & Dovey, 2017).

3. THE INTELLECTUAL EVOLUTION OF THEORISTS IN STUDIES ON URBAN MORPHOLOGY

The urban form is not easily perceived and looks like a face that is attempted to be reconstructed according to general signs without the possibility of knowing its origin, state of view, or life history (Allain, 2004, p. 335). The context of the city can be read by recognizing analytical approaches and applying a set of techniques. Moudon, Vitor Oliveira, and Karl Kropf are among the leading thinkers who categorize approaches to the study of urban morphology.

a. Moudon: Moudon and the International Seminar on Urban Form (Isuf) refer to three Italian, French, and British schools. The three schools together offer an extensive program of research, planning, and design that address the relationships between space, time, habitation, and culture (Moudon, 1994, p. 308).

b. Vitor Oliveira: in his book "Urban Morphology: An Introduction to the Study of the Physical Form of Cities", Oliveira categorizes important morphological approaches that have developed over the past decades as follows. 1. The historico-geographical approach was established after the initial influential activities of Conzen. 2. The typological process approach was developed based on the works of important persons such as Muratori. 3. Space syntax and various types of spatial analysis, such as cellular automata and agent-based models (Oliveira, 2016, p. 102).

c. Karl Kropf: Kropf introduces four categories of approaches to urban morphology in his book "The Handbook of Urban Morphology". Each of them focuses on different aspects of the urban form and uses different methods and tools. The four approaches are typo-morphological, configurational, historico-geographical, and spatial analytical approaches. Typo-morphological and configurational approaches have their roots in the fields of architecture and urban planning. Historico-geographical and spatial-analytical approaches are derived from the field of geography (Kropf, 2017, p. 13).

4. QUANTITATIVE AND QUALITATIVE CLASSIFICATIONS OF APPROACHES TO STUDIES ON URBAN MORPHOLOGY

Morphological studies can be generally divided into quantitative (based on mathematical calculations) and qualitative (based on descriptive analyses) studies. Furthermore, these studies originate from the field of geography and seek to find geographical structure and pattern of human settlements or they originate from architecture and urban planning and seek to find the structure, form, and pattern of urban architecture. In this study, Kropf's classification of urban

morphological studies was specifically selected due to the comprehensiveness of the approaches proposed in morphological studies by Oliveira and Kropf and their overlap. In the following, the proposed classification of this research is presented in the form of quantitative and qualitative studies with the development of Kropf's theories. By examining various theories based on the four schools of thought in morphological studies, the main goals and features, cognitive tools, analytical methods, and design ideas for each approach are introduced.

4.1. Qualitative Studies of Urban Morphology

The historico-geographical and typo-morphological approaches focus on qualitative and descriptive-analytical methods.

a. Historico-geographical approach (geography-based): It has emerged since the early nineteenth century to explain the geographical structure, patterns, and personality of human settlements. One of the main methods of this approach is detailed analyses having a historical sequence of urban plans with a systematic identification of complex hierarchies of plan elements including street pattern, lot pattern, and building pattern (Kropf, 2017, p. 21). It is based on a descriptive-analytical perspective, provides efficient practical tools for recognizing and analyzing urban fabric and enables the designer to recognize the evolutionary development of textures, homogeneous areas, evolutionary periods, and the stable structure of the built environment from a part-whole perspective (Oliveira, 2018). M.R.G. Conzen is an exegete of the historico-geographical approach in Britain, whose works are based on the works of Otto Schlüter, a German geographer of the early twentieth century (Whitehand, 1981).

B. Typo-morphological approach (architecture-based): It is mainly from Italy and France. It is a typological process in the field of architectural education and practice that began in the first half of the 20th century (Kropf, 2017, p. 20). At the end of the eighteenth century, this approach found its theoretical basis for the first time in the Ketromerdoukenesi votes. It enters the literature of architecture and urban planning through the definition of «typo» as the product of an ever-evolving historical process (Torabi Parizi, 2015). The principles of this approach can be found in Muratori and Rossy's activities. Gustavo Giovannoni (1931) and Giancarlo Cataldi (2002) are other activists in this approach (Pinzon Cortes, 2009). Table 1 presents the cognitive tools, analytical methods, and design ideas as well as the principles and thought foundations of morphologists for each approach.

Table 1. Qualitative Studies of Urban Morphology and the Evolution of Morphological Ideas and Principles in the School of Thought of Historico-Geographical and Typo-Morphological Approach

Approach	Main Goals and Characteristics	Cognitive Tools	Analytical Methods	Design Ideas
Historico-Geographical Approach (Geography-Based)	<p>Aim</p> <ol style="list-style-type: none"> 1. Examination of Urban Form and Urban Use Over Time; 2. Understanding of the Urban Landscape with the "Ability of Palimpsest"; 3. Seeking and Interpretation of Existing Forms in Terms of Their Shaping Processes. <p>Special Feature</p> <ol style="list-style-type: none"> 1. Study of the City Map and Building Types in the Form of Morphological Classification. 2. Analytical Study of the Structure of Cities 	<ul style="list-style-type: none"> - Recognition of City Map (Streets, Blocks and Lots) - Recognition of Urban Landscape (Land Use Patterns, Building Texture) - Recognition of Morphological Stabilization Line (ManMade Factors Such as City Fence or Natural Factors Such as a River) - Location of Important Morphological Elements (Natural and ManMade) 	<ul style="list-style-type: none"> - Use of Morphological Structure - Morphological Regions (Homogeneous Regions) <ul style="list-style-type: none"> - Morphological Courses (Which Can Be Recognized as Morphological Regions Under the Influence of Different Cultural Courses) - Marginal Belt (Limits of City Development Throughout History) - Morphological Priorities (Fixed Elements Left Over from Different Periods) 	<ul style="list-style-type: none"> - Adaptive Design in the Form of Redevelopment of a Lot or A Set of Lots Within a Fixed Street System. - Modifiable Design (Up to Date and in Line with Needs) - Complementary Design (Endogenous Development) - Incremental Design (Design of New Urban Structure)
Typo-Morphological Approach (Architecture-Based)	<p>Aim</p> <ol style="list-style-type: none"> 1. Explanation of The Concept of Type as The Internal Structure of Forms; 2. Investigation of How the Evolution of Building Types Affects the Urban Fabric <p>Special Feature</p> <ol style="list-style-type: none"> 1. Attention to the Historical Evolution of Space at Four Scales of Building, Complex, City, And Region; 2. Attention to Urban Architecture; 3. Definition of Typological Process 	<ul style="list-style-type: none"> - Recognition of Major Natural Elements - Building Morphology (Materials, Structures, Arrangement of Rooms, and Building Types) - Urban Texture (Urban Structure) - Urban Organism (a City in Its Entirety) - Recognition of Open Space Network - Recognition of Land-Use and Service Networks 	<ul style="list-style-type: none"> - Abstraction of Building Texture and Urban Space to Find Basic Patterns in the Form of Typological Process - Definition of Basic Type - Understanding of the Main Structure of the Texture <ul style="list-style-type: none"> - Recognition and Analysis of Morphological Elements from Micro to Macro Scale - A Study of the Historical Evolution of Historical Urban Fabric - Modular Reading of the City 	<ul style="list-style-type: none"> - Extension of Historical Structure in New Textures - Definition of the Main Structure in The Combination of Connection Network and Urban Spaces - Application of Spatial-Activity Hierarchies in the Design of New Structures - Establishing A Connection Between the Old and the New with the Help of Public Spaces - Continuation of the Existing Structure by Creating Focal Points and Space-Activity Centers - Definition of Defined Spatial Domains

The Concepts of the Historico-geographical Approach are Taken from (Nickovic, Dokic, & Maric, 2014) and Concepts of Typo-morphological Approach from (Cataldi 1998; Cataldi 2003; Comert 2013; Maretto 2013)

4.2. Quantitative Studies of Urban Morphology

The configurational and spatial analytical approaches focus on quantitative analytical methods.

a. Configurational approach (architecture-based): In the 1960s, it has emerged particularly in Britain from mathematical and quantitative research on architecture and urban form (Kropf, 2017, p. 20). One can mention space syntax and urban network analysis as the proposed techniques in these approaches.

When the core and center of quantitative approaches to the shape of city was created at the center for "Land Use and Built Form" in the 1960s and under

the supervision of Leslie Martin and Lionel March in the mid-1970s at the University of Cambridge. Under Billhailer's control, new incentives to create a «unit for architectural studies» were raised at the University of London. To understand the effect of architectural design on social problems in many buildings built in the UK, research on space syntax in this unit began (Oliveira, 2016). It is possible to provide the weighted representation of the elements of the space network in network analysis (Sevtsuk, 2017), and abstract maps of homogeneous areas with color spectra using the functions of reach, gravity, betweenness, closeness,

and straightness (Sevtsuk & Mekonnen, 2012).

b. Spatial Analytical Approach (Geography-Based): It has emerged from early analytical ideas, such as Von Thünen's Economic Geography and Burgess and Hoyt's dynamic models of urban structure. It focuses on human activities as a set of spatial reactions (Kropf, 2017, p. 21).

This section includes three types of spatial analysis: spacemate technique, fractal analysis, and cellular automata. These three types of spatial analysis may be used as a complement to other approaches because they are not unique. For example, one can mention Michael Batty as an important researcher in promoting this approach (Oliveira, 2016, p. 125). Using a range of methods and models, Batty wanted to understand the spatial structure and dynamics of cities as a complex emerging phenomenon that is created in a global structure of local processes. He considers the city as a complex organized problem. To solve this complexity, he uses the concepts of emergence and evolution. Batty mentioned these models in the book «Cities and Complexity» and it is said that they have a

little correlation with the scale of the phenomena being modeled (Batty, 2005). To quantitatively analyze the forms made in three-dimensional mode, the density of the built environment is studied in the spacemate technique (Jamali, 2015, p. 147). For quantitative analysis in typo-morphology, Berghauser-Pont and Haupt introduced a method called Spacemate, which is based on the relationship between physical density and the shape of the city. This method, as a bridge between quality and quantity, can clearly express the relationship between density and urban form (Berghauser Pont, & Haupt, 2005). It also simultaneously examines four indicators such as intensity or Floor Space Index (FSI), compactness or ground Space Index (GSI), pressure on non-built space or Open Space Ratio (OSR), and height (Layers) (Berghauser Pont & Haupt, 2010). Table 2 represent the cognitive tools, analytical methods, and design ideas, principles and thought foundations of morphologists for the techniques of each approach, in addition to the classification of quantitative morphological studies.

Table 2. Quantitative Morphological Studies and the Evolution of Morphological Ideas and Principles in the Configurational and Spatial-Analytical Approaches' School of Thought

Design Ideas	Analytical Methods	Cognitive Tools	Main Goals and Characteristics	Technique	Approach
Configurational Approach (Architecture-based)	Space Syntax	Aim - Investigation of the relationships between existing elements using metric or topological relationships Special feature - Analysis at the scale of streets and urban blocks through the use of convex spaces and linear and segment maps	- Identification of city map (including accurate identification of urban street network and buildings) - Survey of existing uses and their relationship with movement in space Recognition and analysis of spatial configuration	- Investigation of the characteristics of the urban network through the study of integration, total and partial integration, resolution, and selection indices. - Abstraction of city form to linear map and analysis of the street network at a whole or partial scale (an urban area)	- Representation of urban structure using relative relationships between components - Using a wide range of metrics to study convex spaces and pivotal lines - Description of existing processes and transformation of urban form
	Urban Network Analysis	Aim - Analysis of existing mobility such as selection of residence place, business analysis, or land value Special feature - Unit of analysis in these studies: node or edge. The node refers to the position of the units of each lot on the floors and edges to the street network.	- Full knowledge of buildings - Recognition of street network - Recognition of land-uses - Elevation survey	- Using the five functions of reach, gravity, betweenness, closeness, and straightness in network analysis - Ability to calculate network indices separately for each building - Creation of an abstract map of homogeneous areas for each index, through the color spectrum	- Spatial-functional zoning - Weighted representation of space network elements - Structural continuity - Utilization of some measurable properties such as size, land-use composition, number of residents, employment, and height of buildings in the analysis
	Spacemate	Aim - Classification of urban textures to prescribe development strategies related to each of the spatial types Special feature - Analysis of identical spaces in urban contexts at the plot scale or based on information on the percentage of mass and space, plot area, and number of floors	- Recognition of the lot area - Surveying the number of floors - Surveying building density - Calculation of the floor area ratio - Study of different types of texture with emphasis on the logic or structure of each type	- Identification of basic types of urban texture (including the types of villas, street, villa-street, and block) - Using a two-dimensional diagram showing three dimensions, based on the three indicators of building density, floor area ratio, and network density	- Typology of urban texture on a block scale - Creating a correlation between density and built mass (urban form) - Comparison of texture location with other textures in the diagram in terms of its characteristics
Spatial Analytical Approach (Geography-Based)					

Design Ideas	Analytical Methods	Cognitive Tools	Main Goals and Characteristics	Technique	Approach
Spatial Analytical Approach (Geography-Based)	Fractal Analysis	Aim - Searching for city region organization and location principles and patterns to extract repetitive and changeable rules of urban form Special feature - Study of development rules from the past to the present	- Study of the city map - Study of land use patterns, formation of city form, and patterns of urban growth	- Searching for stages of changes in urban form and predicting the tendencies of development within the city region limits - Using concepts such as similarity, repetition, scale in the study of general changes in the city region form	- Integration with GIS and production of cell maps with the rainbow spectrum - Understanding the structure of regions in the current situation by studying the latent patterns in the process of change in a time process
	Cellular Automata	Aim - Understanding of the rules and behavioral classes of a cellular machine in urban areas Special feature - Major studies investigate development patterns at the scale of the region or specific areas.	- General map of urban areas	- Mathematical ideation of discrete physical systems in space and time and assigning a finite set of discrete values to it - Study of changes in urban areas up to know to identify different periods of development focusing on the status quo	- Graphic representation of urban areas in the form of a checkered grid with full and empty cells (alive or dead) - Discovering the hidden principles in the development process through the abstract study of maps and generalization of them to the future development of urban areas

Taken from (Berghauser Pont & Haupt, 2005; 2010; Sevtsuk & Mekonnen, 2012; Sevtsuk, 2017; Oliveira, 2016; 2018; Kropf, 2019)

5. CONCEPTUAL FRAMEWORK

The constituent elements and relationships of urban form-morphology are introduced in different dimensions to achieve the conceptual framework. In the present study, considering the physical-visual dimension, it is suggested to classify the constituent elements of the urban form in the two branches of "components of urban form-morphology" and «pillars of urban form-morphology» based on theoretical studies and content analysis of texts. According to Figure 1, the urban form is made of mass and space in the category of components. The first section is the mass in which «lots, buildings and blocks» and their «uses» are considered important. The second section is

space in which «street and square» and «activity» are important. They are both examined in terms of body, content, and function. The category of pillars can be evaluated in terms of internal and external relationships. It is dedicated to two groups. The first group is the spatial distribution pattern of elements which includes the «city map» (relationship of each element with its location and bed) and «urban landscape» (how the elements are distributed in the area). The second group is the space syntax of elements which includes «the main structure of the texture» (location of each element in the main structure) and «integration of components» (the degree of integration and relationship of one element with other elements).

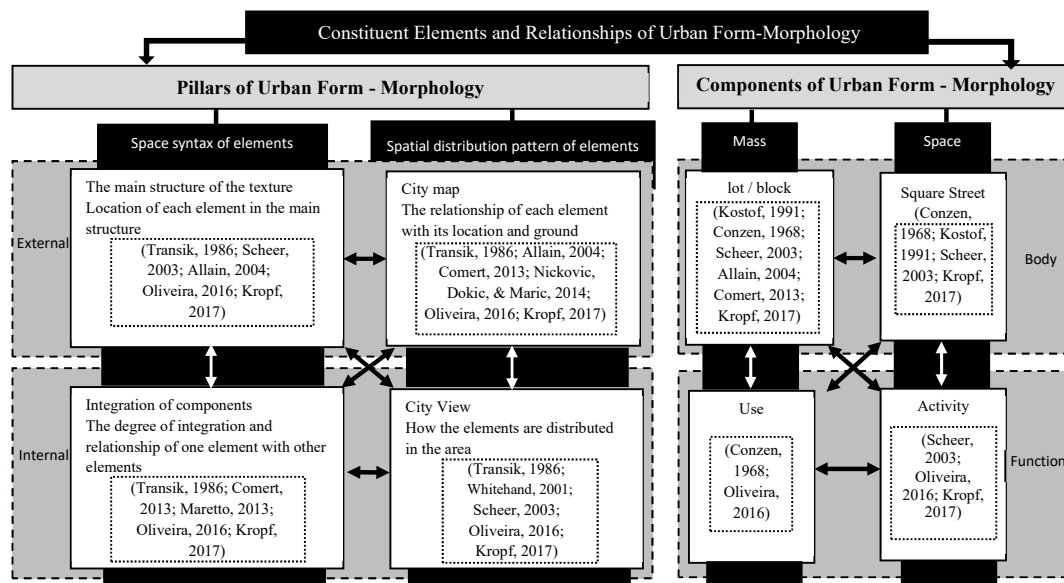


Fig. 1. Conceptual Framework of Urban Form-Morphology

6. METHODOLOGY

The present study was carried out using the mixed method (both qualitative and quantitative methods). It aimed to obtain the most comprehensive urban form-morphology analysis method to assess the case study in the "theoretical foundations" section to investigate the concepts of urban form and urban morphology from the perspective of theorists using exploratory-library studies. To this end, related urban studies carried out in the context of history were introduced into two categories of quantitative and qualitative studies under four form-morphological approaches and their techniques. Then, «cognitive tools, analytical methods, and design ideas» of each technique were identified and described with the directed content analysis of the studies' texts. Next, the «constituent elements and relationships of urban form-morphology» were presented in a conceptual framework by evaluating and summarizing the theories. The constituent elements and relationships of urban form-morphology in Darb-e Babataher Neighborhood were studied and analyzed by assessing the que status of the study area, reviewing overarching plans, survey and field studies, and using AutoCAD and ArcGIS software. Among the analytical methods studied in the "theoretical foundations" section, the urban network analysis technique more comprehensively deals with the constituent elements of urban morphology and the relationships between them. So, this technique, as one of the quantitative techniques of the configurational approach, was selected to analyze the urban form morphology of the

case study. Five main functions of «reach», «gravity», «betweenness», «closeness» and «straightness» were used. In the following, this technique is described.

7. INTRODUCTION OF URBAN NETWORK ANALYSIS TECHNIQUE

This plugin was provided for ArcGIS software to study the spatial organization and space syntax of urban textures and it generally consists of five functions. These functions are written based on the space syntax theory and provide related outputs. In the urban network analysis, the analysis is performed at the scale of buildings, meaning that it is possible to calculate the indices of the network for each building component. This analytical scale enables us to apply buildings with different building densities and uses in network analysis. This is the most important advantage of this technique and also the most important difference between it and other similar analytical techniques. Buildings are represented by points in network analysis and it is assumed that each building is connected to the network through the shortest connection perpendicular to the nearest passage. This representation can be easily done in GIS software in which the origin and destination of travel routes are displayed with geographical points (Sevtsuk, 2010). It is possible to provide the weighted representation of the space network elements in this method. Through color spectra, abstract maps of homogeneous areas are represented using the abovementioned functions (i.e. reach, gravity, betweenness, closeness, and straightness) (Table 3) (Sevtsuk & Mekonnen, 2012).

Table 3. Indices Used in the Urban Network Analysis Method

Indicator	Definition of Index	Function
Reach	The reach index states that by moving from point i, how many neighborhoods j are reached within a certain radius from the point i.	$R(i) = \sum_{j \neq i} 0_{ij} \leq r$
Gravity	The gravity index is directly proportion to the absorption index and inversely proportional to the shortest path distance between i and its neighboring neighborhoods.	$G(i) = \sum_{j \neq i} \frac{1}{d_{ij}^{\beta}}$
Betweenness	Betweenness refers to the sum of the divisions of the shortest paths between other buildings that pass-through point i along their path.	$B(i) = \sum_{j \neq i < j \neq k} \frac{n_{jk}(i)}{n_{jk}}$
Closeness	closeness refers to the inverse of the sum of the shortest distances between the point i and other points in the system.	$c(i) = \frac{1}{\sum_i d_{ij}}$
Straightness	It refers to the sum of the Euclidean (geometric) distances between points i and j over the shortest actual distance between the same points in the graph.	$s(i) = \sum_{j \neq i} \frac{D^{Ecul} ij}{d_{ij}}$

(Sevtsuk, 2017; Sevtsuk & Mekonnen, 2012)

8. INTRODUCTION OF THE CASE STUDY: DARB-E BABATAHER NEIGHBORHOOD

Khorramabad is the capital of Lorestan province. Due to the expansion of the city in new areas and little attention to the old textures of the city, the central district of the city, where was once the residence of the elders and the public, has become abandoned and also a place for social anomalies. The historical and old context of the city include the most valuable historical and cultural monuments of the city, in addition to being a part of the areas and neighborhoods of the city (Abad Boom Consulting Engineers of Qeshm, 2005, p. 4). To assess the morphological components of the city in the mass and space, it can be said that Darb-e Babataher neighborhood is located in the historical core of Khorramabad city. As shown in Figure 2, it is surrounded by Ferdowsi Street on north, Imam Street on east, Hakim (24 meters) Street on south, and Hafez Street on west. In the last half-century, this texture has been neglected by the officials, and become worn out. Therefore, it has been the settlements of poor urban people or immigrants (Abad Boom Consulting Engineers of Qeshm, p. 5). Most of the lots are placed in the northeast-southwest direction. There are various types of small, medium, and large lots. Large lots are located in the vicinity of Falakolaflak Castle and the central parts of the neighborhood. Small lots, with commercial use, are located on the sides of the main

streets surrounding the neighborhood. The average area of the lots is about 137 square meters and their average built area is about 92 square meters, indicating the high floor area ratio. To evaluate the pillars of urban morphology in the two parts of the spatial distribution pattern of elements and the space syntax of elements, it is necessary to mention the capabilities of the area, which show the need to pay attention to the texture. The capabilities are including having suitable location in the city center, the location, and concentration of cultural, educational, service and commercial areas, having the required basic facilities and infrastructure and very high tourism potential, especially in the case of being connected to tourist attractions in the city (Abad Boom Consulting Engineers of Qeshm, p. 6). This neighborhood consists of six blocks. It is difficult to access the heart of the block from the surrounding streets due to the large size of half of them. The pattern of the streets shows that the neighborhood is an organic texture where winding streets and 15 dead-end alleys reduce the legibility of the texture. The neighborhood has 16 intersections only one of which is a crossroads and the rest are y-shaped intersections, implying the low permeability of the texture. The sense of continuity and stability of collective thinking are the valuable features of the historical textures. The importance of urban-form-morphology of the texture and restoration of the lost features are doubled by creating spatial cohesion and integration. The current land-use map of the neighborhood is presented in Figure 2.

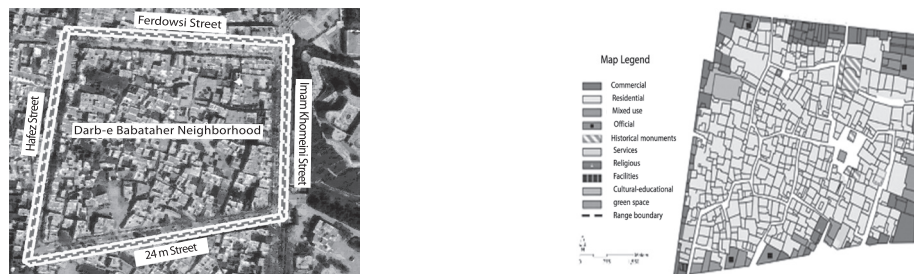



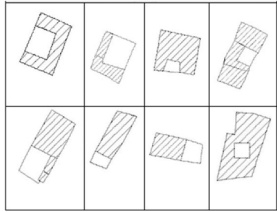
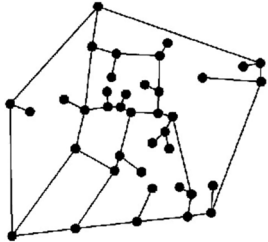

Fig. 2. Location of Darb-E Babataher Neighborhood and Its Current Land-Uses

9. FINDINGS AND DISCUSSION

The UNA technique is an efficient method among the techniques mentioned in Urban Form-morphology Analysis. It analyzes more elements and a wider relationship between elements and urban form-morphology relations. Therefore, it was used as a comprehensive method for analyzing urban morphology in this study. Two main criteria in urban form-morphological studies are access network and land-use. They affect the degree of permeability, mobility and legibility. In this research, the urban form-morphology of the case study was investigated by weighting land-uses in the urban network analysis. This weighting was done based on the Likert scale by dedicating the numbers 1, 3, 5, 7 (1: residential land-

use, 3: mixed land-use, 5: educational and religious land-uses, and 7: commercial land-use) to each of the land-uses according to the opinions of urban experts which were obtained using the Delphi technique. The relationships between the elements of the urban form-morphology were analyzed considering the weights of land uses and their impact on access network and mobility. Table 4 assesses the components and pillars of the urban form-morphology. In the Darb-e Babataher Neighborhood, In the case of components, one can see the organic formation of streets and open spaces as well as historical and old buildings. In the case of pillars, there is an inappropriate distribution of elements and spaces left in the texture, along with the 77% dominance of the mass over the open space in the neighborhood.

Table 4. Assessment of the Components and Pillars of Darb-E Babataher Neighborhood

Assessment of Morphological Components of Darb-E Babataher Neighborhood	
Space	Mass
	
Organic formation of streets 15 dead ends with only one collective space*	Example of land type pattern in the historical center of Khorramabad
Assessment of the Morphological Elements of Darb-E Babataher Neighborhood	
Spatial Distribution Pattern of Elements	Space Syntax of Elements
	
In this map (graph map), the nodes are the intersection of the streets and the edges are the streets (Stavroulaki, Marcus, & Berghauser Pont, 2017). It shows the spatial distribution of the elements.	Black and white map (null map) where spaces and building masses are displayed in black and white, respectively. It shows the main structure of the texture and the degree of spatial integration between the components.

The results of the analysis are available in the hatching spectrum. The reach map was extracted based on the first «reach» function (Fig. 3). According to this map, the access to most of the blocks in the Darb-e Babataher neighborhood was not desirable, as shown with hachure. In addition, there are few connections throughout the texture. Only on the edge of the 24-meter street, there are some lots with slightly better permeability, as shown with denser hachure. The narrow and organic streets in the worn-out texture are the reasons for the same level of access in this neighborhood. This issue indicates that all blocks in the neighborhood do not have adequate access to each other. In the next function, «betweenness» was examined. The betweenness index indicates the existence of proper connections between a building and other buildings. It refers to the sum of the shortest distances between a given building and other accessible buildings within a certain radius (Sevtsuk & Mekonnen, 2012, p. 9). According to the betweenness map, one can see that it is low in half of the blocks in the Darb-e Babataher neighborhood, as shown with spaced hachure. Some lots on the northern edge of the neighborhood (near Ferdowsi Street) have moderate betweenness. Areas with high betweenness, which are shown with closely spaced hachure, are observed in the central part of the neighborhood. According to the

definition of betweenness, one can analyze that some areas in this neighborhood, which are shown as dark, have a greater choice than other areas. In other words, most of the trips taking place in the neighborhood pass through these areas. The selection of areas decreases from the closely spaced hachure to the spaced hachure. In the «straightness» function, some areas have a higher degree of straightness, as shown in dark color. Due to the commercial uses on the edge of the neighborhood, they can be seen in these points. The degree of this index decreases as the density of hachures becomes less. It can be analyzed that the areas marked with dense hachure have higher degrees of straightness and permeability because in them, the ratio of direct access (Euclidean distance) to the actual distance in the network is closer to 1 (Sevtsuk & Mekonnen, 2012). As a result, the street network is in a better condition in those areas. In the areas marked with spaced hachure, the degree of straightness is closer to zero and they do not have a favorable condition. The northern and central-western blocks of the neighborhood have higher degrees of straightness, as seen in Figure 4. Therefore, due to the land-uses, direct access to the street network have more favorable connection in these areas).



Fig. 3. Output Map of Reach Function

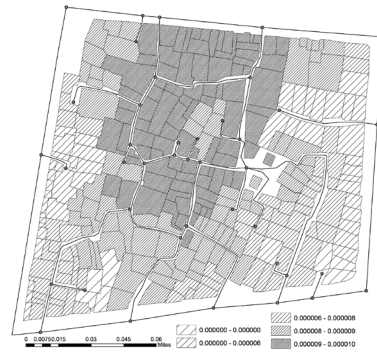


Fig. 4. Output Map of Straightness Function

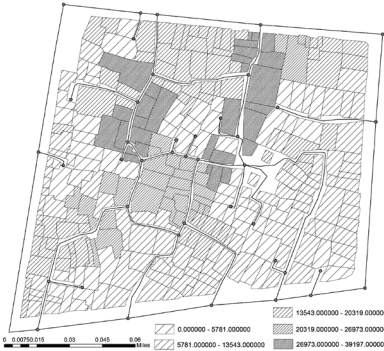


Fig. 5. Output Map of Betweenness Function

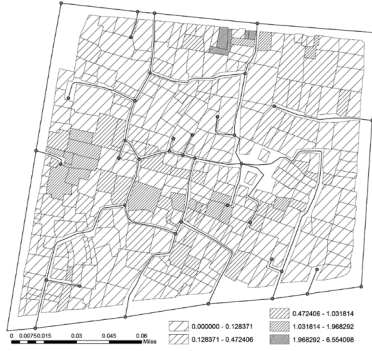


Fig. 6. Output Map of Gravity Function

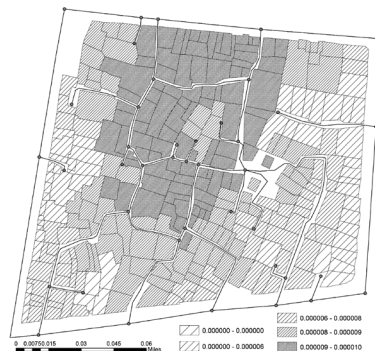


Fig. 7. Output Map of Closeness Function

In the «closeness» map, the dark areas have higher degrees of closeness than other areas and it becomes less by moving towards areas with spaced hachures. The study shows that due to the dark color, the central parts of the Babataher neighborhood have an acceptable condition in terms of closeness. Areas marked with closely spaced hachures, which surround the areas in the dark color, show good closeness. It can also be observed that the closeness decreases by moving from the center of the neighborhood to the eastern and western edges of the neighborhood. In the "gravity" map, as shown in Figure 6, there are only a few lots with dense hachure that have more attraction than other areas. Most lots and blocks are marked with spaced hachures. According to the concept of gravity, very few lots are marked in dark and considered

as areas attracting population inside the Babataher neighborhood.

10. CONCLUSION

To recognize, analyze, and design urban form-morphology, extensive studies have been conducted throughout history. According to Figure 8, all these studies can be categorized into quantitative and qualitative methods and four general approaches (based on Kropf's theory) can be enumerated for them. «Historico-geographical approach» and «typo-morphological approach» are considered for the qualitative method of morphological studies, and «configurational approach» and «analytical-spatial approach» for the quantitative method of

morphological studies. The historical study of the urban form over time and the urban landscape analysis with the ability of palimpsest are used in the historico-geographical approach, the typological process analysis and urban fabric (urban structure) analysis in the typo-

morphological approach, space syntax technique and urban network analysis in the configurational approach, and the cellular automata technique, fractal analysis, and spacemate technique in the analytical-spatial approach.

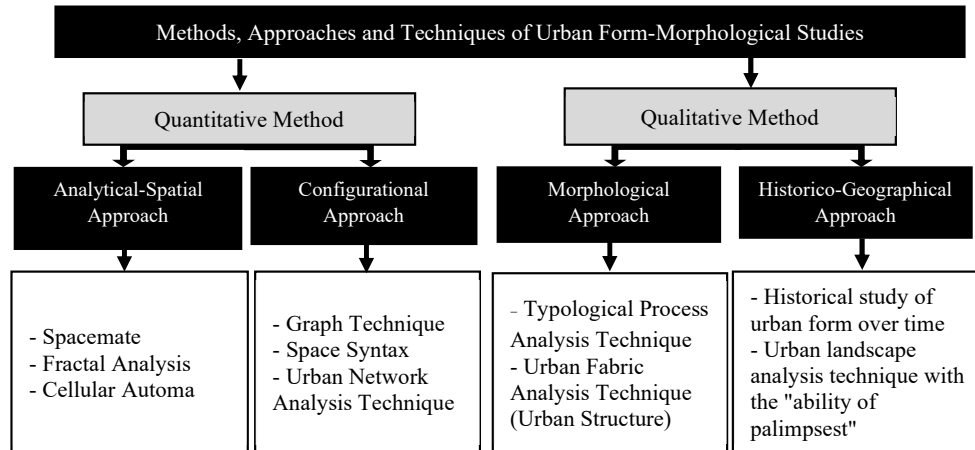


Fig. 8. Introduction Diagram of Urban Form-Morphological Study Techniques

We encounter the evolution of the urban form design process in the studies and by examining the ideas of theorists in urban form-morphological analyzes throughout history. In this research, for each approach, «cognitive tools», «analytical methods» and «design ideas» have been identified along with the principles and foundations of morphologists' ideas. One can mention some cognitive tools such as city map (streets, blocks, and lots), urban landscape (land-use patterns and building texture), morphological stabilization line (man-made factors such as city fence or natural factors such as a river), important morphological elements (natural and man-made), urban organism and spatial configuration; some analytical methods such as abstraction of building texture and urban space and definition of basic types, a study of historical developments of texture, use of morphological areas (homogeneous areas), morphological courses (which can be surveyed as morphological areas under the influence of different cultural courses), marginal belt (limits of city development throughout history), morphological priorities (fixed elements left over from different periods) and the modular reading of the city; some design ideas such as adaptive design (redevelopment of a lot following the existing texture, application of spatial-activity hierarchy), modifiable design (up to date and in accordance with the needs, continuity of the existing structure by creating focal points and spatial-activity centers, representation of urban structure using relative relationships between components), complementary design (endogenous development, extension of historical structure in new textures, connection between old and new textures, description of existing processes and evolution of urban form) and incremental design (design of new urban structure, definition of the main structure in the combination of connection network and urban spaces)

can be enumerated as design ideas. In the present study, it has been attempted to redefine the elements and relationships forming urban form-morphology to analyze the form-morphology of the city. Therefore, through the ideas and views of theorists throughout history, the «components of urban morphology» and the "structure of urban morphology" have been extracted. Urban morphological components such as plot, building, block (mass), street, and square (space) should be examined in terms of body, content, and function. Urban morphological structure, like spatial distribution pattern of elements, includes city map (relationship of each element with its location and ground), urban landscape (distribution of elements in the area), space syntax of elements including the main structure of the texture (location of each element in the main structure, and the integration of components (the degree of integration and relationship of one element with other elements). The UNA technique can be used as a comprehensive analysis technique in assessing urban form-morphology since it deals with space (square and street) and mass (plot and block) (among the elements of urban form-morphology), the distribution of elements, the effect of each on the other and the degree of integration of components (among the relations between the elements) and covers more urban form-morphological elements and more connections. As the most fundamental elements affecting the urban fabric, «street» and "land-use" have been evaluated as variables of the urban network analysis technique. The results of the five functions of this technique (reach, betweenness, straightness, gravity, and closeness) indicate that the historical texture of Khorramabad is becoming uninhabited, despite its high potential for tourism due to the valuable historical identity and the presence of prominent morphological elements. The Darb-e Babataher Neighborhood has large-scale

blocks and low permeability to the lots inside the block due to presence of long, organic, and narrow streets, increasing the sense of insecurity in addition to reducing the legibility of the texture. The «gravity» function is based on Newton's laws. It is inversely proportional to distance and its square and directly proportional to mass. In other words, in urban blocks, there is more gravity if the distances are closer and the weight is greater. In the Darb-e Babataher neighborhood, the lots have a low degree of gravity. Considering the weights of land-uses, this function does not consider the neighborhood attractive to the population despite having a valuable historical texture. Therefore, based on respect for valuable historical past, it is suggested to combine complementary design, endogenous development, and adaptive design with the preservation of morphological elements and the main character of the texture to revive the texture and invite the residents to stay, as well as attract tourists and boost the neighborhood economy. The "reach" function examines the level of access to most of the blocks in the Darb-e Babataher neighborhood. Due to the large-scale blocks, this index shows the unfavorable condition of the accesses, the narrowness of the streets, and the presence of many dead ends. It is suggested to strengthen the structure of the texture to improve the reach index in the neighborhood. By observing the functional scale, it is possible to achieve full integrity with the proper space syntax of texture components and proper connection between them in the existing context. The "straightness" function shows that the study neighborhood has more permeability and intra-local streets can provide the connections between buildings because the ratio of direct access (Euclidean distance) to the actual distance in the network is

closer to 1. Enhancing the permeability of the texture and establishing the spatial integration between a component with other components, improve the quality of public space. The «betweenness» function shows the appropriate connections between a building with other buildings in the neighborhood by examining the sum of the shortest distances between each building with other accessible buildings within a certain radius. To improve this index, the following strategies are of great importance: modifying access and establishing the desired hierarchy of connection network, facilitating simultaneous movement flows, proper location and creation of space-activity centers, provision of proper access to these centers, introducing required land-uses, and providing services fairly in the neighborhood. The "closeness" function shows the inverse relationship with the sum of distances. The smaller the sum of the distances, the higher the degree of closeness and better spatial organization is achieved. In the central part of the neighborhood, the sum of the distances was small and therefore buildings were accessed more quickly. In other words, the possibility of providing services in the center of the neighborhood, which has a high degree of closeness, is higher than non-compact units. The closeness index is inversely proportional to the weight, meaning that the greater the weight, the low the degree of closeness. To improve the closeness index in neighborhoods, it can be useful to strengthen and stabilize the character of urban neighborhoods in historical textures by improving the landscape of the access network, paying attention to texture grading and landscaping, embedding appropriate furniture in public areas, and creating climatic comfort to enhance public attendance and reminiscence.

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