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Spatial Configuration of the Architecture of Shiraz City (Iran) In Two Periods of Zandieh and Contemporary

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ABSTRACT: By examining the modern cities of Iran with a historical background, it is evident how the changes in city structure over the past few decades have impacted the lives of individuals in society. Among these Iranian cities, the city of Shiraz is notable. The historical background of the city of Shiraz dates back to the sixth century BC. Over time, due to natural and governmental factors, the city's structural patterns have undergone significant changes, each unique in its time, with specific positive and negative spatial effects resulting from its type of spatial organization. This research aims to examine the transformations in spatial configuration within urban spaces over time and to identify patterns and qualitative and quantitative characteristics that affect these transformations, with a particular focus on the reorganization of the general disorganization in the structure of Shiraz City. The methodology of this research is based on documenting the evolutionary process, incorporating logical reasoning.

Additionally, relevant materials and maps have been obtained through observation, field surveys, and library studies, which the authors have redrawn for clarity. Subsequently, the maps were analyzed and evaluated using UCL Depth Map, a specialized software for spatial syntax, and the results are presented. The findings and analyses conducted in this research indicate that the historical transformations of spatial configuration have deteriorated the historical context of Shiraz due to its physical expansion, reducing the quality of its urban environment.

Keywords: *Space Configuration, Space Syntax, Shiraz City, Urban Space Structure, UCL Depth map Software.*

INTRODUCTION

The city is a connected and interconnected collection of urban spaces (including streets and squares) that encompasses fundamental elements and main activities (Bazi & Dolati, 2013). Cities have always played a pivotal role in human development, and as humanity has progressed, various factors have contributed to the evolution and transformation of city configurations over time. Understanding and recognizing these changes in the spatial-physical structure of urban environments and guiding them toward coherence and spatial balance across various physical, social, and economic dimensions is essential (Movahed et al., 2019). One of these factors is urban population growth, which has led to unequal access to essential infrastructure and created disparate spaces within the urban fabric (Figueiredo et al., 2021). Furthermore, the dynamics of urbanization have evolved in response to changes in the social and economic organization of cities worldwide (Korkmaz & Balaban, 2020). Urbanization appears to be an unstoppable phenomenon, and according to the United Nations, it is projected to result in 68% of the global population living in urban areas by 2050 (Mirzakhani et al., 2021). All of these factors lead to profound spatial-physical transformations, known as urban upgrading and renewal, or, in other words, urban modernization, resulting in both positive and negative changes in the construction, configuration, and fabric of Iranian cities. It appears that these changes have significantly impacted residents' perceptions of the city and its urban landscape (Soltanifard & Ghassemi, 2018), with one of the most crucial changes being the misalignment of historical urban areas with contemporary urban development plans (Sadeghi et al., 2012). The configuration of the city, as the form that shapes the urban skeleton and structure, significantly influences the way urban spaces are interconnected and arranged. Consequently, some of its parameters have played a more prominent role in shaping the urban structure over time, while others have not (Ghorbani et al., 2023). The physical expansion of Shiraz has

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undermined its historical context and reduced its urban environmental quality (Hanachi & Fadaeinezhad, 2010). This research examines the spatial configuration of Shiraz across two historical periods—the Zand Dynasty and the contemporary period—using space syntax theory. The main objective is to analyze the changes in urban planning and their impact on spatial logic, especially within the city's historic fabric. The study addresses three key questions: (1) How has the spatial structure of Shiraz changed from the Zand Dynasty period to the present? (2) What impact have modern planning interventions had on the continuity of the traditional urban form? (3) To what extent have the parameters of spatial configuration techniques influenced the spatial coherence of Shiraz over time?

The research hypothesis is that contemporary developments have caused fragmentation and reduced the coherence of the historic fabric, leading to the loss of the city's spatial logic. This study analyzes and compares maps from the Zand Dynasty period and the current maps of Shiraz, utilizing quantitative indicators derived from axial and visual graph analysis to identify patterns and both qualitative and quantitative characteristics of the city's spatial structure transformations.

Literature Review

A review of the literature indicates that numerous comparative and corrective studies have been conducted based on this approach over the past decades. Researchers identify Bill Hillier's first book, titled The Social Logic of Space, published in 1984, as a pivotal work in introducing this theory (Yazdanfar et al., 2008). Today, this method has a variety of applications, with the first implementation of the Space Syntax model in Iran being related to its use in the urban design process of Yazd by Mostafa Abbaszadegan (Tabarsa et al., 2019). The results of this research demonstrated that urban spaces are structured according to specific logic. Furthermore, intervening in the arrangement of space transforms its spatial structure, and structural transformations in the city will lead to changes in the functional-behavioral patterns of stakeholders (Abbaszadegan, 2002).

To date, there has been no independent research on the historical transformations of Shiraz City's spatial configuration and the comparison of urban structures between the Zand Dynasty and contemporary times using space syntax methods. However, many studies have been conducted in other fields that focus on space syntax to examine re-recognition, changes, and transformations in urban structure and their reflection in the design of urban space development. Table 1 summarizes previous applications of space syntax in urban structure, highlighting methodological gaps. This background supports the relevance and originality of the study, forming the theoretical

Table. 1: Literature Review on the Configuration of Urban Spaces in Shiraz Issues Using the Space Syntax Method.

.No	Article Title	Authors	Research Method
1	Analysis of the Spatial Structure of Tabriz City within the Citadel Boundaries Using Space Syntax Technique	(Yazdanfar et al., 2008)	In this study, by examining the historical citadel area in Tabriz over two historical periods using the Space Syntax method, it was concluded that there is a significant difference in accessibility and functional importance between the city's old organic fabric and the new post-street-planning fabric. This difference has disrupted spatial balance and reduced the efficiency of spaces.
2	Examination of Spatial Isolation of Dilapidated Fabrics in the Structure of Tehran City Using Space Syntax	(Rismanchian & Bell, 2011).	This study examines the spatial characteristics of dilapidated neighborhoods within the context of a special renewal plan, employing the Space Syntax method and drawing on the theory of Natural Movement. The spatial isolation of dilapidated neighborhoods within the structure of Tehran is examined using the Space Syntax method, with the results providing substantiated evidence regarding the nature of this spatial isolation and addressing the lack of validity in historical studies. Additionally, the differences between forced and voluntary spatial isolation in various urban contexts are highlighted, and a practical approach is presented for understanding this complexity.
3	Investigating the Impact of Contemporary Urban Development Plans on the Spatial Structure of the Historical Core in Northern Isfahan	(Sadeghi et al., 2012).	This research examines one of the fundamental problems in the historical areas of Iranian cities: the misalignment with contemporary urban development plans. In the historical core of northern Isfahan, this issue stems from a lack of understanding of the city's structure and form, leading to the gradual erosion of the old urban fabric and the imposition of a new grid structure following the construction of cross streets. Initially, the structure of this city was analyzed across four significant periods of physical transformation using the Space Syntax method. The findings suggest that recent urban interventions, undertaken without a contextual approach and consideration of the existing physical context, have resulted in the spatial and structural isolation of historic neighborhoods.
4	Investigating the Transformation of the Spatial Structure of Tabriz during the Qajar Era Based on Historical Maps	(Balilan, 2014).	This research examines the evolution of historical maps of the city of Tabriz during the Qajar era to identify the most significant changes in the city's spatial structure during this period. Given the historical nature of the topic, data collection will be conducted using a descriptive method with a historical and documentary approach. Additionally, the analysis of the data will be informed by comparative-analytical studies. Ultimately, the study aims to highlight the key characteristics of each spatial structure in Tabriz across three different periods of the Qajar era.

Continiue of Table. 1: Literature Review on the Configuration of Urban Spaces in Shiraz Issues Using the Space Syntax Method.

.No	Article Title	Authors	Research Method
5	Analysis of Urban Morphological Changes in Dhaka, Bangladesh, Using Space Syntax	(Ahmed et al., 2014).	This article is based on the study of morphological changes in Dhaka, the capital of Bangladesh. The primary aim of this research is to examine the transformation of urban morphology in Dhaka from 1947 to 2007. Three sample areas (18, 19, and 72) from Dhaka municipality have been strategically selected as study regions. Area 72 represents an organic, indigenous settlement, while Area 19 is a planned region, and Area 18 exemplifies a mixed type of settlement (both planned and informal). In this study, the evolution of urban settlement patterns is examined through the lens of space syntax. The results indicate that organic settlements (Area 72) are highly integrated in both local and global syntactic measures (showing the lowest standard deviation for local and global integration and the highest intelligibility values) and exhibit greater connectivity. This scenario is reversed for planned settlements. The characteristics of mixed areas (Area 18) lie between those of organic and planned settlements. Therefore, in summary, it can be stated that the measures of integration, connectivity, and intelligibility in Dhaka are evaluated as high, moderate, and low, respectively, for indigenous, mixed, and planned settlements.
6	Allometric in Street Network Syntax: The Evolution of Adriatic and Ionian Coastal Cities (1800–2010)	(Shpuza, 2014).	This research examines urban growth concerning the impact of size on the metric and topological criteria of space syntax, which describe street networks. A quantitative analysis of three historical phases of Adriatic and Ionian coastal cities is supported by a unique database of historical maps and axial map representations. The comparison between the three historical phases reveals that allometric depth relative to axial map size at the ontogenetic scale, which transcends various types of street patterns, growth models, and physiological conditions, maintains statistical equality. In contrast, relationships between allometric depth, choice, and entropy concerning size reveal distinct universal classes between the coastal cities of Italy and the Balkans, as well as between cities with and without network street patterns.
7	The Impact of Physical Changes on the Spatial Structure of the Historic Site: A Case Study of the Historical Area of Urmia	(Lotfata & Lotfata, 2018).	This article examines the impact of recent urban interventions on the spatial and physical structure of cities in Iran. These interventions have altered the initial spatial organization and the city's main structure. Understanding the structure and core skeleton of cities based on the analysis of all their components is difficult and often impossible. This research aims to investigate the impact of urban development plans on the spatial structure of historical areas in Urmia and to analyze the city's structure across four important periods (1309, 1353, 1375, and 1395) using space organization methods. The results of this study indicate that the functionality and coherence of the historical area, along with its connection to the city's overall structure, have diminished due to physical changes over time. Furthermore, the internal structure of this area has failed to connect to the overall city structure. A significant portion of the identity and physical values of the fabric have been lost due to the disconnection of key elements in the area. The functional importance of historical orders has weakened, suggesting that rapid physical changes have harmed the spatial structure of the historic area.
8	Analysis of the Relationship between Spatial Structure and Urban Sprawl of Neighborhoods Using Space Syntax (Case Study: Shiraz)	(Movahed et al., 2019).	This research investigates the negative impact of urbanization and physical transformations on the structure of Iranian cities. The article investigates the relationship between urban sprawl and the spatial structure of the city by analyzing 20 indicators across 111 neighborhoods in Shiraz. For structural analysis, the Space Syntax method and linear maps within the DepthMap software were employed. The results indicated a significant inverse relationship between the integration value of the spatial structure and urban sprawl.
9	The Impact of Speed Orientation on Urban Structure Transformations on a Global and Iranian Scale (Case Study: Shiraz)	(Pourtazak et al., 2019).	This research employs the Space Syntax method and the integration value criterion to investigate the urban structure of Shiraz across four distinct eras, analyzing urban structural transformations. For the structural analyses, the urban axes were initially mapped using AutoCAD, followed by transferring the drafted map to DepthMap software for integration analysis. A detailed examination of the present era, encompassing an analysis of physical infrastructures, virtual systems, and various travel methods, revealed the dispersion and prevalence of mainly east-west axes with multiple movements and speeds, particularly concentrated in the middle fabric of Shiraz. Consequently, through the connectivity and balanced distribution of the derived axes, achieving a cohesive urban structure becomes feasible.

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.No	Article Title	Authors	Research Method
10	Application of Space Syntax Technique for Comparative Analysis between the Spatial Structure of Historical Fabrics and New Urban Developments (Case Study: Historical Fabric and Farhangian Town of Gorgan)	(Tabarsa et al., 2019).	This research examines the spatial structure of cities as the result of various processes from social, economic, cultural, and physical dimensions. With changes in these processes, new forms of spatial structure emerge. Thus, comparing the spatial structure of different eras can reflect the social and economic dimensions as well as the settlement patterns of various periods. The Space Syntax technique is a powerful model of spatial syntax that can interpret spatial patterns concerning social contexts. This study is used to conduct a comparative analysis between a portion of the historical fabric of Gorgan and relatively new urban developments in the city. The research results indicate that the design values derived from the social context of traditional life within the historical fabric, characterized by greater privacy, selective separation, and less mixed-use, have shaped a hierarchical network of pathways that generally lead to increased security and tranquility. In contrast, Farhangian Town, as a newly planned urban area, has shifted its design values toward accessibility, permeability, and higher spatial connectivity, with a predominance of streets over living spaces. Consequently, people today tend to prefer living in spaces with shallower depths and greater accessibility.
11	Analysis of the Impact of Physical Changes on the Spatial Structure of the Historical Area of Urmia City Using GIS and Space Syntax	(Abedini et al., 2019).	This research investigates how recent urban interventions have led to significant transformations in the spatial structure of Iranian cities. During this period of physical development, many historical cities have encountered challenges such as an inability to adapt to physical changes and a lack of proper connections with the existing network structure, resulting in problems for their historical cores. By analyzing the impact of urban development plans on the spatial structure of the historical area of Urmia, this study investigates the city's structure across four periods (1395, 1373, 1355, and 1312) using Space Syntax. After analyzing the parameters and maps, the changes in integration value were considered the most critical concept in this method. The results indicate that the performance and coherence of the historic area and its relationship with the overall structure of the city have diminished over time due to physical changes, and the internal structure of this area has not been effectively con-.nected to the overall city structure
12	Evaluating the History of Cities in the Context of Spatial Configuration for Previewing Their Future	(Günaydin & Yücekaya, 2020).	As cities grow, their morphological and spatial configurations change. In this context, integrating old urban areas with newly planned regions is crucial. This integration not only preserves elements of urban identity but also ensures the sustainability of cities. This study examines the evolution of Gaziantep's spatial characteristics in response to zoning plans implemented throughout its history. The Space Syntax method was utilized to determine its spatial features. As a result, it was observed that with urban growth, comprehensibility and accessibility values generally decline.
13	Investigating Urban Spatial Growth Using Space Syntax and GIS: A Case Study of Famagusta	(Atakara & Allahmoradi, 2021).	This research examines urban morphology to investigate how a city evolves and changes, thereby visualizing its embedded history. The study examines the potential of utilizing Space Syntax and GIS methods to analyze the morphological evolution of traditional centers over historical periods. By examining the spatial characteristics of syntax, human activities, and movement patterns within the city, the levels of integration and connectivity of urban spaces can be assessed. Through the syntactical analysis of street networks, urban planners can gain a deeper understanding of urban growth evolution and obtain new insights to aid in the development of new urban areas. Indeed, this study brings scientific accuracy and attention to detail regarding spatial growth and morphological evolution in Famagusta. The findings highlight that socio-economic processes and physical configurations play significant roles in the development of a city, benefiting the community.
14	The Impact of Spatial Changes in the Historical Area of Shiraz on Perceived Anti-Social Behaviors	(Moqadam & Nubani, 2022).	This research examines how the growth of cities can lead to changes in their spatial configurations over time. The study aims to investigate the impact of spatial configuration changes in the historical area of Shiraz on perceived anti-social behaviors (ASB). Spatial combination techniques were employed to assess the extent to which these changes influence perceived levels of anti-social behaviors. Historical and contemporary maps of the city were obtained and analyzed spatially using DepthmapX. Unplanned changes also introduced numerous fragmented street segments, challenging the connectivity of internal streets to other parts of the city. The spatial metrics employed in this study can serve as valuable tools for planners, urban designers, and policymakers to assess the impact of proposed urban reforms on social behavior and the quality of life for residents.

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.No	Article Title	Authors	Research Method
15	Investigating Physical Interventions in Historical Textures and Their Impact on Cohesion and Continuity of Spatial Organization: A Case Study of the Historical Texture of Tabriz City	(Ghorbani et al., 2023).	This study examines how the city's main structure significantly influences the connection and spatial arrangement of urban spaces. This paper aims to explore the practical application of Space Syntax techniques in analyzing the configuration and main structure of Tabriz's historical texture over the past century. By conducting a comparative analysis between historical periods (1297, 1349, and 1400), the study analyzes Space Syntax parameters (connectivity, integration, depth of space, and choice) using axial maps, presenting results in graphical and mathematical data. The findings suggest that the axes and paths of the historical and central textures of Tabriz have lost their significance and role; however, they still possess the potential and capacity for revitalization within the city's main structure.

foundation for the current research.

MATERIALS AND METHODS

The methodological framework of this research is based on documenting the evolutionary process through critical reading and interpretation of relevant texts and published articles related to this approach, as well as analyzing historical documents to understand the historical transformations of the city's skeleton. The study focuses on examining urban development plans for Shiraz, including comprehensive and detailed plans, to enhance information and continue the research process. To clarify the rationale for the selected methodology, Space Syntax was chosen due to its ability to objectively quantify spatial configuration, legibility, and accessibility, making it a suitable method for comparing traditional and modern urban structures. Additionally, empirical and syntactic analyses are conducted to assess the structural aspects of the studied area and to track changes using axial maps, which were collected through field visits to the cultural heritage sites and the national fabric database of Shiraz. Fieldwork involved direct observation of changes in neighborhoods, as well as the historical and untouched fabrics of Shiraz, which have undergone minimal transformations in their configurations, alongside newly developed areas of the city with modern urban structures. In this study, the primary focus is on the historical core of Shiraz and its surrounding areas, as this zone allows comparison with maps from the Zand Dynasty period and was selected as a representative sample due to the possibility of field verification. However, by utilizing the axial map of the entire city, the broader spatial structure of Shiraz has also been analyzed. Nonetheless, the spatial scale of the research remains a limitation; despite the precision of the analysis, the full complexity of Shiraz's metropolitan configuration may not be entirely captured. Also, a key limitation of this study lies in the extensive physical alterations within the historical structure of Shiraz, which in many areas has disrupted the direct correspondence between historical maps and the current urban layout. Consequently, some traditional spatial patterns can no longer be directly observed in the field, which may affect the accuracy of morphological comparisons across time.

This approach aimed to recognize the spatial-formative parameters and the attached spaces, allowing for an update of land-use maps in the studied area to align with the status. To analyze the physical environment and morphological characteristics, as well as to interpret syntactic criteria that complement this study, the UCL Depthmap software was utilized. Initially, the axial maps of Shiraz were drafted in AutoCAD, and these maps, consisting of axial lines, were then analyzed using Depthmap. The methodological process in this research consists of 3 steps, which are clearly shown in Figure 1. These steps include establishing the theoretical foundation, collecting data, conducting spatial modeling, and finally analyzing and interpreting the results. This diagram clarifies the logical structure of the study. The quantitative and qualitative components derived from these evaluations are compared in corresponding tables and graphs with other maps. Ultimately, the results are examined using logical reasoning, leading to a conclusion regarding the recognition and re-identification of the transformations in the configuration of Shiraz over time.

Urban Space Structure

Urban spatial structure is a commonly used term in urban literature, with various definitions offered based on its conceptual and practical breadth. Each of these definitions contains concepts and characteristics primarily derived from the perspective and expertise of the contributor (Haghjou et al., 2016). The concept of spatial structure refers to an abstract or general definition of the distribution of phenomena in geographic space. According to some scholars, the spatial structure of a city refers to land use patterns, forms, shapes, and layouts of urban blocks, as well as the distribution of activities, elements, and components that constitute the city (Nazarian, 1991). Overall, the urban spatial structure is a composite system consisting of a backbone and an interconnected network of various and diverse urban land uses and elements (Movahed et al., 2019). From the perspective of space syntax, space is the primary and novel concept, as, in this view, the city becomes the space between buildings rather than the mass of those buildings (Mirgholami, 2015). Space reflects a pattern of arrangement. Within this framework, the structure of cities and urban areas is not randomly formed; rather, it follows a self-evident plan related to time and social and economic conditions (Tabarsa et al., 2019).

Urban Space Transformations

A city is a spatial and physical phenomenon that is created at a specific point evolves, and transforms its quantitative changes into

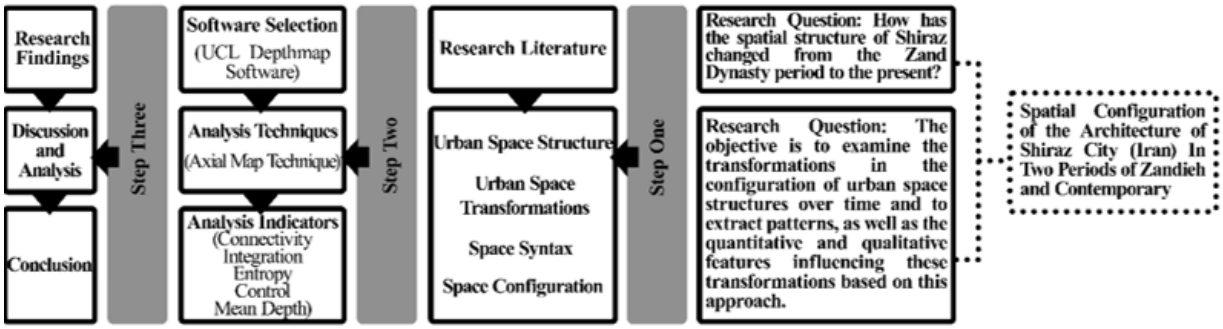


Fig. 1: Diagram of the Research Methodology.

the qualitative changes required by its era at each point in history (Phelps, 2015). According to Japanese architect Makii, the city is a living entity that undergoes structural changes over time; thus, a stable structure can be defined for it, while other variables are its branches (Salingaros, 2013, 78). Continuous transformations in urban structure at a macro level are primarily driven by urban development and urbanization over time, which directly impacts the nature and form of the city and, consequently, the urban landscape (Ebensaleh, 2000). These transformations shape the spatial structure through their spatial and social logic, aligning it with the cultural and social context and the surrounding physical environment (Rapoport, 1992). Additionally, spatial and physical transformations in cities, aside from economic development and urban infrastructure (Liu & Liu, 2018), have multiple consequences, including imbalances in the spatial distribution of various services and facilities, as well as the fragmentation of urban structures (Wang et al., 2020).

Space Configuration

Spatial configuration refers to the arrangement of spaces concerning one another and their interrelationships. Thus, any change in the arrangement of spaces will create changes at the overall level of spatial configuration, influencing the amount and manner of activities within the space (Jeong et al., 2015). The spatial configurations of a city are governed by the spatial distribution of movement, which is "naturally" shaped by spatial arrangement (Hillier & Hanson, 1984). In space syntax, the term "configuration" is primarily used to refer to a network of spaces. In the context of an environment's map, configuration represents all possible ways in which spatial units are depicted to interact with each other. However, configuration illustrates a network state that describes the relationships between individual spatial units (Atakara & Allahmoradi, 2021).

Space Syntax Theory

The term "syntax" generally applies to linguistics, but Bill Hillier developed it for analyzing architectural and urban design concepts (Sharma, 2015). Space syntax comprises a collection of theories and methods for analyzing cities that use space as the fundamental generator of the city (Karimi, 2018). Professor Bill Hillier and his colleagues at the Bartlett, University College London, developed space syntax in the 1980s. This method has been widely applied in the fields of urban planning, urban design, architecture, transportation planning, and interior design (Bayes et al., 2014). The configuration of urban networks is studied within the analytical framework of space syntax, which is based on two theories related to movement: 1) Space syntax addresses street connectivity to identify spaces that have easy access in comparison to more segregated spaces (Hillier, 1999); and 2) Space syntax proposes innovations regarding the relationships between urban space and movement, whether by vehicles or pedestrians (Hillier et al., 1993).

Axial Map Analysis Approach

Among various combinatorial analysis approaches in space syntax, axial line analysis is chosen as a suitable method for analyzing and examining the configuration of the city of Shiraz. An axial line represents the longest line of access and visibility in an urban environment (Abbaszadeh, 2002). In space syntax, axial lines are used to simplify the connections between spaces that form urban morphology (Atakara & Allahmoradi, 2021). An axial map is a simplified representation of the streets and open urban spaces formed by axial lines, serving as the basis for analyzing the spatial arrangement of a city (Tabarsa et al., 2019).

Quantitative Indicators Influencing Space Configuration

Connectivity: Connectivity is a measurement parameter that indicates the relationship between a space and its immediate neighboring spaces (Didehban et al., 2013). It signifies spatial connections, reflecting the degree of interaction between nodes and axes with other neighboring nodes within a particular area. The numeric value of connectivity specifies the number of access points leading to the targeted space (Yazdanfar et al., 2008).

Integration: Integration is the primary concept in space syntax. The integration value for each line (or space) represents the average number of intermediate lines (or spaces) that must be crossed to reach all other spaces in the city. Higher integration in a space indicates a greater coherence with other spaces and the overall spatial organization of the city (Sajjadzadeh et al., 2016). Due to its sensitivity to urban morphological changes, the integration parameter can be effectively applied in urban design processes, particularly during the evaluation

and analysis of various plans (Ghahri et al., 2024).

Mean Depth: Depth refers to the number of spaces one has to pass through in a city to reach a specific destination. The greater the spatial depth, the less accessible a space becomes, isolating it from the city's spatial framework. Depth has an inverse relationship with integration; in other words, spaces with high integration have lower depth (Azari & Heydarzadeh, 2011). Lower spatial depth means that a space or path is more embedded within the urban fabric, thus amplifying its privacy. Designers can strengthen these low-depth spaces and elevate them as fundamental components of the main structure (Raford & Ragland, 2003).

Visual Entropy: The entropy index measures the difficulty of accessing other spaces from a given space. A space with higher entropy has a greater depth of symmetry relative to its adjacent spaces and thus provides easier access. Conversely, a lower entropy value indicates a more unbalanced spatial structure and reduced accessibility (Yakhchali et al., 2023).

Control: Control measures the likelihood of a space being chosen at a given urban node. Essentially, the control value of a space can be defined by its relative potential to attract neighboring spaces. Generally, higher control signifies greater spatial integration, which in turn affects the amount and patterns of movement within urban spaces (Shahinifar & Charehjoo, 2022).

The city of Shiraz, the capital of Fars Province, is situated at 52°30' E longitude and 29°30' N latitude (Movahed et al., 2019). Shiraz is situated at an elevation of 4,186 meters above sea level, within the mountainous region of the Zagros, and enjoys a moderate climate. It is the third largest city in Iran, after Tabriz and Tehran (Nowrozi & Sabzehalipour, 2017). In the country's political map, the city's name appears in various historical documents under names such as Tirazis, Shirazis, and Shiraz (Sarmadi, 2012). Shiraz has a history spanning over 1,300 years (Afsar, 1995, 24), and it is home to significant architectural landmarks, including two UNESCO World Heritage sites that were formed in different historical periods. Over time, the city has undergone extensive structural and spatial transformations, which have subsequently impacted various aspects of its spatial configuration. Figure 2 shows Shiraz's location at various scales and identifies the specific area analyzed. This spatial context reinforces the urban relevance of the findings. To visually analyze Shiraz's historical transformations, all historical visual documents have been gathered and presented in Table 2.

Table 2 presents archival and visual documents from various historical

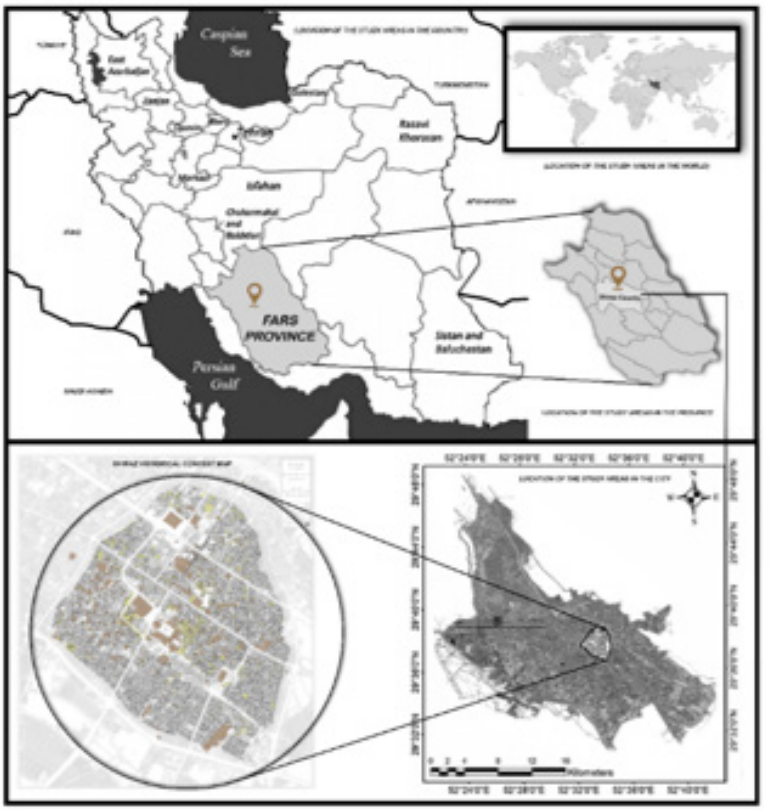


Fig. 2: Location of the study areas in the world, country, and city.

Table 2: Historical visual documents of Shiraz city.

Source	Historical Map	Drawing & Year
(Chizfahm-Daneshmandian & Nejad-Ebrahimi, 2022)		Niebuhr (1765 A.D.)
(General Department of Cultural Heritage of Shiraz)		Tavasoli (1794 A.D.)
(General Department of Cultural Heritage of Shiraz)		Chirikov (1850 A.D.)
(Chizfahm-Daneshmandian & Nejad-Ebrahimi, 2022)		Mirza Hassan Fasa'i, Motofi (1898 A.D.)
(General Department of Cultural Heritage of Shiraz)		Wilbur (1935 A.D.)
(Chizfahm-Daneshmandian & Nejad-Ebrahimi, 2022)		Alami (2008 A.D.)
National Heritage Fabric Base) of Shiraz)		Mohammad Soltani (2024 A.D.)

periods. These sources provide the spatial basis for comparing changes in urban morphology. The intersection of styles and architectural techniques over time in historical cities has caused notable inconsistencies in their appearance and led to the deterioration of some urban textures (Varesi et al., 2012). This process has also influenced the cities' spatial configuration. Historical urban textures are an undeniable reality in cities with historical backgrounds. Traditional Iranian cities had a unique structural form (Ghorbani et al., 2023). Figure 3 compares traditional and modern urban structures in Iran. This comparison frames the morphological transformation of Shiraz as a representative case.

This study examines two maps of Shiraz: an 18th-century hand-drawn historical map from the Zand dynasty period and a contemporary detailed urban development map from the 21st century prepared by consulting engineers. Shiraz was selected for several reasons. Firstly, the researchers have direct access to the location. Secondly, the historical fabric of Shiraz, like other Iranian and global cities, has undergone significant transformations due to urban expansion over time. This area currently hosts a variety of central commercial, religious, service, and

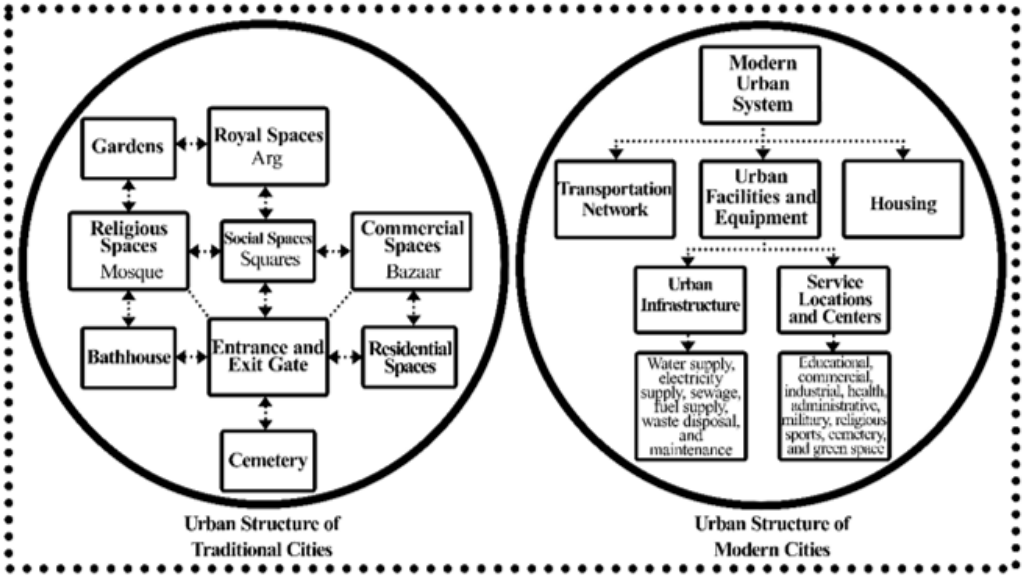
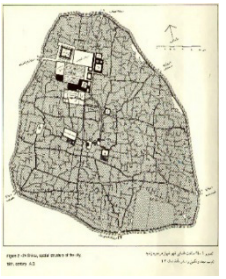
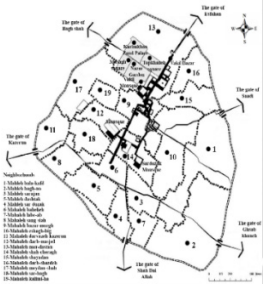
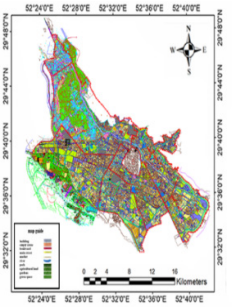
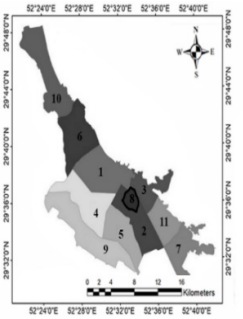


Fig. 3: Urban structure diagram of Shiraz.

Table 3: Introduction of Case maps in Shiraz city.

Background	Area	Map of Shiraz City	Urban divisions diagram	Urban structure	Source
Zand Dynasty-18th. Century .A.D	The approximate area of Shiraz during this historical period was 378 hectares.	 (Source: General Department of Cultural Heritage of Shiraz)		A wall with six entrance gates surrounded Shiraz during the Zand Dynasty. Within its urban structure, there were spaces such as Vakil Bazaar, Vakil Bathhouse, Vakil Mosque, Arg Karimkhani, Nazar Garden, two squares (Toopkhaneh and Mashq), and 19 neighborhoods surrounding them.	(Varesi et al., 2012), (Chizfahm-Daneshmandian & Nejad-Ebrahimi, 2022), (Lak & Hakimian, 2018)
Contemporary period-21th. .Century A.D	Noted. Shiraz's approximate area today is 24,000 hectares.	 (Source: General Department of Cultural Heritage of Shiraz)		Today, the city of Shiraz is divided into 11 municipal districts. The oldest urban fabric of Shiraz comprises part of the central area (D.B.C.), which has its municipality and forms the 8th district of Shiraz. Additionally, 10 other adjacent districts have been added around this historical fabric over the past three centuries due to extensive urban transformations.	(Kiani & Amirinejad, 2013)

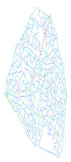
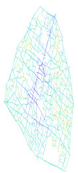
administrative activities and holds considerable potential, both realized and untapped, for promoting tourism, religious visits, commerce, culture, and residential life (Varesi et al., 2012). Table 3 introduces the base maps used for axial and visual graph analysis. The standardization of these maps enables valid cross-period comparisons.

RESULTS AND DISCUSSION

After determining the study area, the authors of this research first redrew the maps for analysis in Depth Map software. These maps were prepared to achieve analytical indices using the mentioned methods. Table 4 shows key spatial indicators extracted from DepthMap software, including integration and connectivity. The results highlight sharp contrasts between the two periods studied, which we will analyze in the following section.

Like many other cities in the country, the metropolis of Shiraz has experienced increasing urban population growth, urbanization trends, and migration, resulting in a heightened demand for urban necessities such as housing, transportation, and urban services in recent years (Rezaei & Karimi, 2016). Currently, one of the most important areas of this city, regarded as its historical and cultural heart, encompasses District 8 of Shiraz, which marks the starting point of the city's formation. This area has undergone structural transformations over various periods to the extent that the physical expansion of Shiraz has compromised its historical context and diminished the quality of its

Table 4: Space Syntax Analysis of the Urban Structures of Shiraz city on Ucl depth map software

Contemporary period-21th. Century A.D	Zand Dynasty-18th. Century A.D.	Background
		**Original maps**
		**Connectivity**
		**Integration**
		**Mean Depth**
		**Control**
		**Visual Entropy**

max min

urban environment (Hanachi & Fadaeinezhad, 2010). At first glance, comparing two plans of Shiraz reveals significant urban structural changes over the past three centuries. The beginning of these changes dates back to the late Zandieh era, when the central government merged several neighborhoods for better urban management, reducing the number from 19 to 10 neighborhoods. Notably, the names of the former neighborhoods have mostly remained and can still be found on local streets (Chizfahm-Daneshmandian & Nejad-Ebrahimi, 2022).

Furthermore, the early Pahlavi era saw the commencement of fundamental urban transformations with the construction of cross streets during Reza Khan's reign. As shown in Table 5, the average values of key spatial configuration indicators indicate a decline in connectivity and an increase in integration during the contemporary period compared to the Zand Dynasty. Additionally, Figure 4 visualizes the numerical averages across different spatial attributes, clearly illustrating the syntactic contrast between the two periods studied. Subsequently, the following diagrams and analyses provide a deeper examination of the qualitative and quantitative components affecting urban configuration in the two historical maps from the Zandieh dynasty and the modern city of Shiraz.

Connectivity

In the old map of Shiraz, we see that the axis of the market street has the highest level of connectivity due to the significant focus on commercial spaces in traditional Iranian urbanism. After the market, the street networks connecting to the city's main gates also exhibit high connectivity, as all these paths eventually lead to the market. Another noteworthy point is that these routes penetrated residential neighborhoods, effectively serving as a bridge between the market and the people, ensuring that all neighborhoods had easy access and mobility to the market. Additionally, when examining the current map of Shiraz, we notice that streets with high connectivity have formed outside the historic fabric of Shiraz. It can be confidently stated that urban planning developments in Shiraz have bypassed the historic fabric, leading to the emergence of main streets with high connectivity at the edges of this fabric. Only a few main streets, such as Lotf Ali Khan Street, Zend Street, and Hazrateh Street, pass through the old fabric, which has not solved the connectivity issues. Instead, fragmented streets have made it difficult for the internal streets to connect with the rest of the city, resulting in isolated neighborhoods like Sang Siah, Darb Shazdeh, and Lab Ab within the old fabric.

Furthermore, these streets attract significant traffic flow. According to Figure 5, by comparing the two historical and current maps of Shiraz, we have realized that the city's configuration in the past had higher connectivity compared to the present state, as all key urban elements—such as the market, squares, streets, and residential neighborhoods—

Table 5 The numerical average of attributes.

No.	Background	Connectivity	Integration	MeanDepth	Control	Entropy
1	.Zand Dynasty-18th. Century A.D	3.57	0.75	11.49	1	3.84
2	Contemporary period-21th. Century A.D.	3.11	1.00	10.83	1	3.60

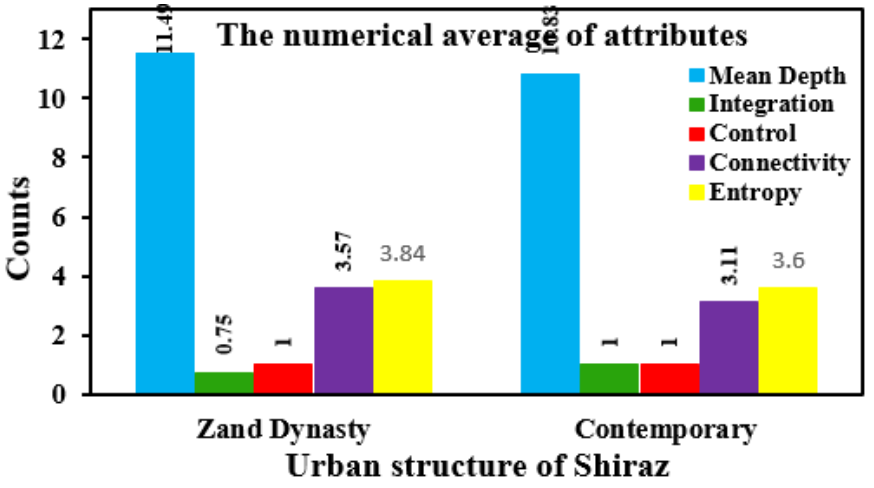


Fig. 4: The numerical average of attributes.

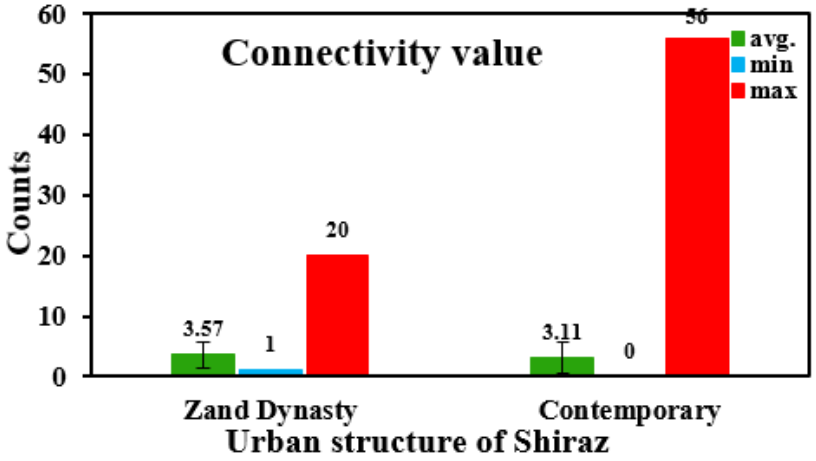


Fig. 5: Connectivity value in the urban structures of Shiraz.

followed a hierarchical urban pattern. This aspect contributed to greater connectivity.

Integration

According to researchers in this field, spaces with higher levels of integration also have greater accessibility, indicating a linear relationship between integration and the connectivity index. A highly integrated line can be accessed from all other lines in the system with the fewest number of steps. As shown in Table 4, which presents the integration map of Shiraz, the highest levels of integration are concentrated around the market. Furthermore, in alignment with this significant continuity within the city, elements such as mosques and bathhouses are strategically placed, following an intelligent pattern in the configuration of Iranian cities. This reflects the emphasis on religious values and cleanliness among Iranians. Upon closer inspection, we observe that the Isfahan Gate and the Shah Garden Gate, situated in the northern and northwestern parts of Shiraz, respectively, exhibit the highest levels of integration among all the gates. A logical reason for this high level of integration seems to be the proximity of three main squares in the city—Mashq Square, Topkhaneh Square, and Shah Square—to these gates. When we analyze the contemporary map of Shiraz, we find that Zend Street and Modarres Street exhibit the highest levels of integration and connectivity. It is noteworthy that Modarres Street is a newly constructed street, as its axis completely bypasses the historic fabric of the area. Today, several important administrative and recreational centers have been established along this street, contributing to the migration of people from the historic neighborhood of this city to newly built areas with better access to amenities. These poorly planned physical changes have resulted in significant disorganization, primarily along several integrated routes.

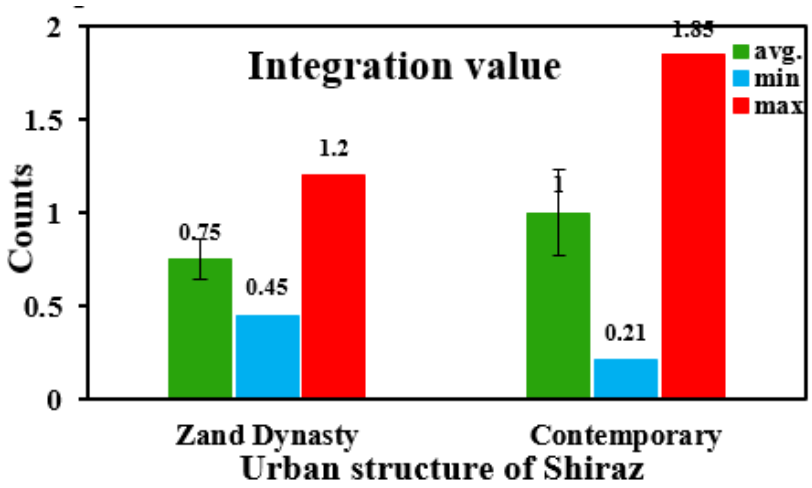


Fig. 6: Integration value in the urban structures of Shiraz.

As shown in Figure 6, by comparing the two historical and current maps of Shiraz, we observe that the city's configuration in the past had lower integration compared to its current state. Previously, coherence was only evident around the market; however, over time, the cross-street constructions that began during Reza Khan's era have fragmented the urban structure, reducing the overall connectivity of the entire city with the historical fabric. New streets, such as Modarres Street, now exhibit higher levels of integration.

Mean Depth

As we know, the depth index has an inverse relationship with the integration index. Analyzing the map from the Zand period in Table 4 reveals that the market area had a high level of integration, which consequently placed it at a lower depth. In contrast, the neighborhoods surrounding this area exhibited greater depth, indicating a higher degree of privacy during the Zand period. Moreover, in the royal area of the city, where the Karim Khan Citadel is located, we observe an average depth. Specifically, the axis running from the Nazari Garden, which connects to the market, has a shallower depth compared to the axes connecting the citadel to the market. In examining the new map of Shiraz, we note that with increased migration from the old fabric and new developments in some areas of the city—resulting in urban sprawl—the lack of integration in these regions is evident. As a result, the spatial depth in these areas has also increased, which not only does not adhere to the principles of spatial privacy but also signifies the isolation of these areas. According to Figure 7, by comparing the historical and current maps of Shiraz, we find that the city's configuration in the past had greater depth compared to its current state. This is because neighborhoods were formed based on spatial logic, and traditional Iranian urbanism placed significant emphasis on the principle of spatial privacy.

Control

This parameter predicts the extent of functional pathways in terms of their relative strength in attracting potential from neighboring spaces and the selection of space among others in spatial nodes. The likelihood of these paths being chosen by citizens for movement and activities is higher. For example, in the current map, the connecting route between Namazi Square and Vali Asr Square exhibits greater controllability compared to other axes. Additionally, in Table 4, the Zand period map, the high level of integration along the bazaar axis has also increased its controllability, reflecting its capacity to enhance communications and interactions, consequently elevating the level of oversight in that area. In the new structure, which follows new roadway infrastructures to facilitate vehicle movement, we find that this road development has led to a disconnection between historical sites, impacting social interactions and movement patterns among residents. Researchers examining the effect of spatial configuration on pedestrian movement patterns in urban spaces have argued that areas lacking oversight can become conducive to crime and various levels of public disturbance (Cohen & Felson, 1979). According to Figure 8, by comparing the historical and current maps of Shiraz, we observed that the city's configuration in the past exhibited a similar level of control to its current state. However, the maximum controllability of these two urban structures shows significant differences.

Entropy

The parameter of entropy determines the ease and difficulty of accessing a space. By examining the historical map of Shiraz, as shown in Table 4, we found that the connecting paths between the bazaar, mosque, and bath to the neighborhoods, as well as the path connecting the bazaar to the main squares of the city, exhibit low entropy. Additionally, the alleys leading to the bazaar and the movement axes around the squares and the citadel are wider, which not only increases pedestrian presence but also enhances accessibility in these routes, thus impacting the ease of access to these spaces. Now, by examining the new map of Shiraz, we realize there is a significant difference between the maximum and minimum levels of entropy, which proves the structural disorder in the city of Shiraz. Consequently, this leads to an increase in permeability difficulty. By comparing the two historical and current maps of Shiraz in Figure 9, we find that the configuration of Shiraz in the past had higher entropy compared to its current state. As a result, the spatial privacy and depth of the spaces have also increased. Moreover, since entropy measures the ease of access to all spaces, it

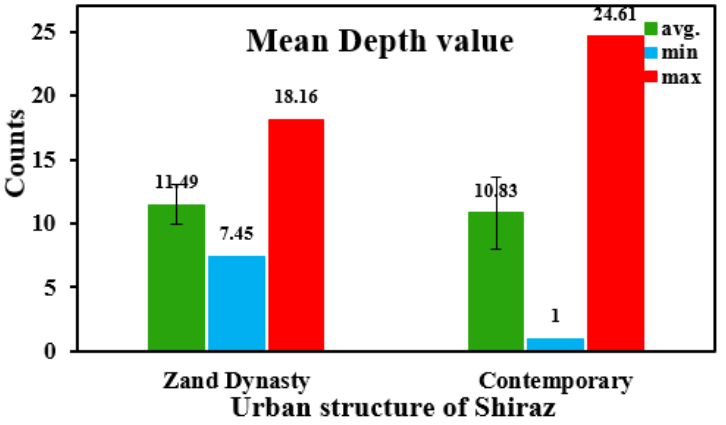


Fig. 7: Mean Depth value in the urban structures of Shiraz.

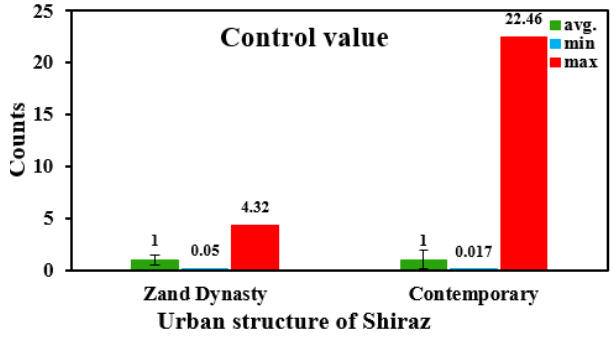


Fig. 8: Control value in the urban structures of Shiraz.

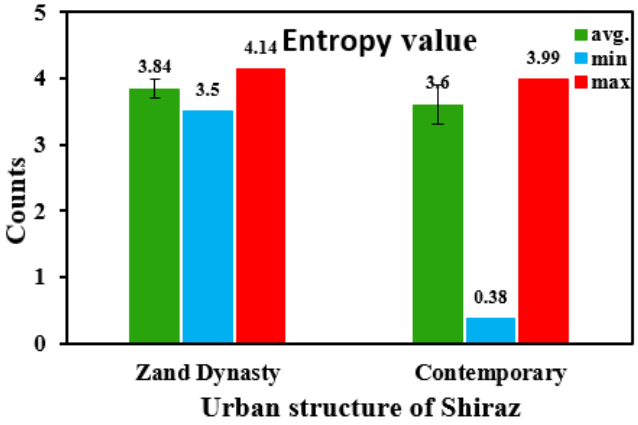


Fig. 9: Visual Entropy in the Urban Structures of Shiraz.

Table 6: Comparative Interpretive Analysis.

Case of Analysis	Zand Dynasty-18th. Century A.D.	Contemporary period-21th. Century A.D.	Quantitative/Qualitative Difference	Author's Interpretation	Spatial Implication
Integration and Centrality	High concentration of spatial integration in the historical core (around the bazaar).	High concentration of spatial integration in the urban periphery (e.g., Modarres Street).	↑ 0.25 (0.75 - 1.00)	The increase in integration values in the contemporary period is primarily due to the expansion of wide, newly constructed peripheral streets rather than reflecting actual spatial integration.	Fragmentation of the historic core and the loss of its spatial prominence.
Connectivity of Neighborhoods	Reduced connectivity, segmented and isolated blocks.	A strong linkage exists between neighborhoods and the main bazaar.	↓ 0.46 (3.57 - 3.11)	Reduced connectivity in the historic core reflects the deterioration of internal urban networks.	The weakening of spatial relationships between neighborhoods and the growing fragmentation between historical and contemporary urban layers.
and Choice Pedestrian Movement	The bazaar axis was aligned with the pedestrian movement flow.	The newly developed streets are primarily designed to facilitate vehicular movement.	↓ (qualitative)	Movement in the traditional structure was based on a hierarchical pedestrian network, whereas the contemporary layout prioritizes vehicular flow.	A loss of continuity between pedestrian and vehicular networks accompanies the reduction in walkability.

Continiue of Table 6: Comparative Interpretive Analysis.

Case of Analysis	Zand Dynasty-18th. Century A.D.	Contemporary period-21th. Century A.D.	Quantitative/Qualitative Difference	Author's Interpretation	Spatial Implication
Mean Depth and Hierarchy	Higher spatial depth in residential neighborhoods compared to the bazaar area, ensuring spatial privacy.	Irregular spatial depth, a fragmented pattern, and lack of hierarchical organization.	↓ 0.66 (11.49 - 10.83)	The high spatial depth in peripheral areas is not rooted in the logic of spatial privacy but rather indicates isolation and disconnection.	Decline in spatial privacy and the disappearance of route hierarchy.
Control and Visibility	Control values were concentrated in historic nodes such as the bazaar and city gates.	Dispersed control and the dominance of modern streets.	↔ (1.00 = 1.00, No change)	Although the control index remains stable, the dominant spatial nodes have shifted from historic to modern zones.	Loss of control concentration in heritage cores; disintegration of spatial logic.
Entropy and Urban Readability	Ease of access and high permeability along the axes connected to the main squares, leading to the Arg and the bazaar.	Difficulty in equal access to various urban areas and a concentration of permeability in the central part of the city.	↓ 0.24 (3.84 - 3.60)	Lower entropy indicates greater difficulty in spatial navigation and reduced natural accessibility in the contemporary layout.	Emergence of spatial disorder and reduced urban legibility.

can be said that, regarding the accessibility index recognized by the entropy tool, the central part of Shiraz has higher accessibility and permeability compared to other areas.

Table 6 summarizes the comparative analysis of key spatial indicators between the Zand Dynasty and contemporary periods, along with the author's interpretation and spatial implications.

CONCLUSION

A glance at today's cities in Iran reveals that the structural changes occurring in our urban environments over the past few decades not only lack traditional characteristics but also fail to meet contemporary needs (Sheybani et al., 2017). As we know, an ideal urban structure is one where the historical fabric exhibits higher connectivity compared to the rest of the city, enabling this historical core to foster cohesion and unity among the city's other elements. However, we have found that alongside population growth outside this historical perimeter and urban expansion—which has resulted in increased spatial depth within the historical fabric—the connectivity of this historical area has diminished. It is noteworthy that the neighborhoods experiencing the most deterioration are situated in this region, characterized by the shortest axial lines, the greatest spatial depth, the least connectivity, and a low level of accessibility. The spatial arrangement has clearly illustrated how these events have unfolded. Shiraz dates back to the 6th century BCE, meaning many historical sites are located within this historic area, forming the foundation of a spatial configuration where the connection between these spaces was more critical than the connection of streets to one another. Consequently, people naturally lived in proximity to one another; however, this natural presence is now disrupted by streets, leading to a decline in quality of life (Moqadam & Nubani, 2022). Moreover, the unplanned street constructions for urban development have fragmented and isolated the historical neighborhoods, creating conditions conducive to crime and various levels of public disturbance. Another observation is that in the areas surrounding the citadel and main squares, such as Towhid Square and Mashq Square, the movement axes are wider and gradually extend toward the city gates.

Additionally, the alleys connecting to the bazaar are wider than those in other neighborhoods, enhancing the accessibility of these routes, which consequently increases pedestrian movement and presence around these spaces. Overall, the findings support the study's hypothesis that uncoordinated modern developments have weakened the spatial logic and continuity of Shiraz's historic urban structure. These transformations have disrupted the traditional spatial hierarchy and diminished the cohesion between core urban elements, highlighting the long-term consequences of disconnected planning decisions. Interestingly, Shiraz is now recognized for its lack of cohesion in the continuity and width of sidewalks, ornamental features, and limited access to commercial areas, green spaces, and recreational facilities (Bahrainy et al., 2015). Therefore, re-examining and comparing the structure and spatial organization of historical fabrics with new urban developments can aid planners and designers. Analyzing spatial arrangements can serve as a valuable tool for assessing their impact on various outcomes and perceptions of urban spaces. Therefore, the following recommendations are derived from the study's spatial findings.

- Apply space syntax tools in early design stages to simulate spatial outcomes and prevent fragmentation in future urban expansions.
- Limit car-dominant infrastructure within the heritage zone to avoid further disruption of spatial logic.
- Reinforce pedestrian-centered planning by restoring traditional

pathways that once connected the bazaar and neighborhoods, improving walkability and spatial continuity.

- Encourage finer block structure and integrated layouts in new developments to reduce excessive mean depth and prevent spatial isolation.

However, given the performance-oriented nature of such research, it is suggested that future studies on the historical transformations of urban spatial configurations should also address the following topics:

- Re-identifying and analyzing factors that enhance the mobility and accessibility of individuals to historical areas within old neighborhoods through the reform of urban development planners.

- Re-establishing positive and negative patterns and their continuity in shaping modern neighborhoods and organizing traditional neighborhoods within the historic fabric.

- Evaluating historical transformations of urban spatial configurations in various historical cities in Iran and comparing them with the historical fabrics of other countries.

Overall, to improve and preserve the correct configuration of our communities and neighborhoods, the findings of this study can be useful for policymakers, planners, and researchers in evaluating the impacts of proposed changes on urban spatial development.

AUTHOR CONTRIBUTIONS

F. Haghbin was responsible for collecting data from the Shiraz Cultural Heritage Department, preparing axial maps, conducting spatial analyses using specialized software, designing charts and illustrations, and drafting the initial manuscript. P. Hessari was responsible for the overall research idea, developing the theoretical framework and research methodology, providing academic supervision throughout the study, and reviewing, editing, and finalizing the manuscript.

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CONFLICT OF INTERESt

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the authors have acknowledged the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, which have been fully addressed.

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