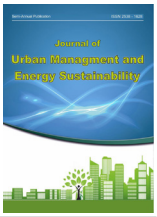
International Journal of Urban Management and Energy Sustainability (JUMES)

Homepage: http://www.ijumes.com



CASE STUDY RESEARCH PAPER

Evolution in the Figure-Ground Relationship of Public-Government Buildings in the First Pahlavi Period (Case Studies: The Museum of Ancient Iran and the Post Office Building, Tehran)[1]

Nesa Hajmoradi[1], Gholamreza Talischi[2*], Seyed Jalil Mousavi[1], Kianoosh Zakerhaghighi[3]

1 Department of Architecture, Ha.C., Islamic Azad University, Hamedan, Iran
2 Assistant Professor, Department of Architecture, Faculty of Art and Architecture, Bu-Ali Sina University, Hamedan, Iran*
3 Department of Urban Planning, ST.C., Islamic Azad University, Tehran, Iran

ARTICLE INFO

Article History:
Received 2025-05-12
Revised 2025-08-22
Accepted 2025-09-26

Keywords:
First Pahlavi period, public buildings, urban modernization, figure-ground analysis, space syntax analysis

ABSTRACT

The rapid urban modernization developments during the first Pahlavi era, breaking away from historical patterns, transformed the physical appearance of Tehran in an unprecedented way. In the meantime, modern public buildings, as symbols of modernity, played a pivotal role in redefining the spatial organization of the city. One of the prominent manifestations of this transformation is the change in the figure-ground relationship of buildings with their urban context. The research method is a combined approach based on a comparative approach and a case study in three basic steps: identifying public government buildings built in a specific time period; analyzing the spatial configuration and evaluating the degree of physical-functional adaptation and the relationship of spatial structure with functional logic. This research aims to reveal the hidden logic of spatial organization of modernization projects, and provides an analytical framework for evaluating the physical-social effects of landmark buildings in historical contexts. The study was conducted using space syntax analysis methods, figure-ground analysis, and historical and field documentation of the sites, and in this regard, Depth-Map software was used to analyze the spatial configuration and impact of public buildings during the reform period. The findings and conclusions show that the construction of public and government buildings during the first Pahlavi period led to the strengthening of macro-connectivity in the urban context, and the increase in local connectivity and high connectivity, the continuation of cohesion and dynamism at the micro-scale are clearly visible.

DOI:10.22034/IJUMES.2025.2069633.1323

Running Title: The Figure-ground Relationship of Public-Government Buildings in the Early Pahlavi Period

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
28	7	13

*Corresponding Author:
Email: talischi@basu.ac.ir
Phone: +989188153587
ORCID: https://orcid.org/0000-0002-0173-2719

1. This article is taken from the first author's doctoral dissertation entitled "Explanation of the Form-Ground Relationship in the Architecture of the First Pahlavi Period (Case studies: Museum of Ancient Iran, Post Office Building in Tehran, and National Bank, Tehran Bazaar Branch)", which is being conducted at the Islamic Azad University, Hamedan Branch, under the supervising of Dr. Gholamreza Talischi and Dr. Seyed Jalil Mousavi, and with the advice of Dr. Kianoosh Zakerhaghighi.

INTRODUCTION

Tehran, as the capital of Iran, witnessed significant developments in the field of urban development during the first Pahlavi period (1320-1304 AH). The urban developments of Tehran during the first Pahlavi period, with their emphasis on modernism and distancing themselves from traditional patterns, led to fundamental changes in the physical and spatial structure of the city. These changes, following the approval of the Municipality Law in 1309 AH, turned Tehran into a model for modern urban development in Iran. New streets, as a symbol of modernity, became the main axis of development and weakened the position of traditional bazaars and old neighborhoods. These changes, influenced by the architecture and industrial urban development of the 19th century Europe, were carried out with the aim of creating an efficient and developed city and broke its historical continuity. The creation of wide streets, new squares, and government buildings transformed the traditional concepts of the city into modern concepts, and the traditional social, economic, and cultural relations of the city gave way to new structures. The urban developments of the Pahlavi period coincided with the formation of new public buildings that were recognized as symbols of cultural, social, and economic changes of that time. These buildings, in relation to the street, as the main symbol of these developments, changed the spatial organization of Tehran and formed a new quality in the spatial organization of the Iranian city. Therefore, in the study of these developments, the relationship between the architectural building and the urban context is of particular importance. Examining this relationship can help to more accurately understand the aforementioned changes and understand the concepts of organizing the contemporary Iranian city and its relationship with public buildings. The relationship between a building and its urban context, or in other words, the relationship between the form-context of the building and its urban context, is a dynamic relationship that shapes both the spatial personality and the socio-cultural identity of the building and the city. To comprehensively understand this relationship, combining Roger Transick's (1986) urban spatial design theories with the analytical capabilities of spatial syntax provides a multidimensional framework. This article combines theoretical perspectives based on the theories of figure-ground, communication, and place with spatial syntax tools, especially Depth-map, to study the spatial, functional, and cultural connection of the Post Office and the Museum of Ancient Iran, built during the first Pahlavi era, with the urban spaces of Tehran. The Museum of Ancient Iran and the Post Office located on Sepah Street are among the most prominent examples of buildings from the era of urban transformations in Tehran during the first Pahlavi era, which are of great importance not only in terms of architecture but also in terms of their placement in the urban context and interaction with their surrounding environment. The main issue of this research is how the Museum of Ancient Iran and the Post Office, as two prominent public buildings from the first Pahlavi era, have influenced urban organization and social interactions from the perspective of figure-ground relationship and spatial configuration, and how can these effects be analyzed and interpreted over time and in the context of contemporary changes in the urban context?

MATERIALS AND METHODS

The relationship between urban spaces and buildings is a dynamic one that requires a detailed understanding of the morphological, connectivity, and cultural significance of the connections between them. To examine these relationships, it is necessary to use spatial design theories such as Roger Transick's theories (figure-ground, connectivity, and place) and the analytical framework of spatial syntax. Figure-ground theory analyzes the geometric and visual structure of urban spaces and examines the relationship between "masses" (buildings)

and "empty spaces" (public and open spaces), which helps to understand spatial patterns and how buildings affect the surrounding spaces. Connectivity theory emphasizes connections and movement networks and analyzes communication routes and the impact of buildings on accessibility and spatial cohesion. Place theory also considers the cultural, social, and historical aspects of urban spaces and helps to identify the spiritual and symbolic role of buildings in the urban network. In addition, spatial syntax adds a quantitative dimension to the analysis of spaces, examining spatial configurations and their connectivity, which allows for the measurement of criteria such as integration and accessibility (Trancik, 1986). The combination of these theories and methods contributes to a comprehensive and detailed analysis of the interactions of buildings and urban spaces, allowing architectural designers as well as urban designers and planners to create spaces with optimal visual, social, cultural and functional values. Figure-ground theory emphasizes the visual and geometric organization of urban forms and examines the relationship between solids (buildings) and voids (open spaces). Although this theory is successful in identifying spatial patterns and textures, it remains largely qualitative. Spatial syntax provides a complementary quantitative dimension that analyzes the spatial configuration of voids and their connectivity (Hillier & Hanson, 1984; Hillier et al., 1986). In the Shiraz bazaar, figure-ground analysis of the bazaar's organization as a structure using spatial syntax can be quantified with criteria such as global coherence and local connectivity to examine the effectiveness of voids in facilitating movement and interaction. For example, the courtyards and open spaces of the bazaar—which are important voids in the urban context—can be analyzed in terms of accessibility and their role in the spatial hierarchy. This integration helps urban designers identify and enhance spaces critical for pedestrian flow and social activity (Lak & Hakimian, 2018). Connectivity theory emphasizes connections and pathways that unite urban elements and prioritizes movement networks and spatial coherence (Trancik, 1986). Spatial syntax complements this focus by mapping and analyzing path networks to assess their role in urban accessibility and clarity (Hillier & Hanson, 1984; Hillier et al., 1993). In the Kerman bazaar, connectivity theory suggests the existence of a "grand form"—a unified structure that connects key urban elements such as the citadel, mosque, and main gates. Spatial syntax can complement this analysis by developing axis and effectiveness maps to measure the values of integration and route selection. These measures indicate how effectively the bazaar connects different parts of the city and facilitates the movement of pedestrians. For example, the role of the bazaar as a central artery that facilitates economic and social interactions can be measured, improving our understanding of its connectivity at urban scales (Lak & Hakimian, 2018).

Place theory emphasizes the cultural, historical, and human-centered aspects of urban spaces and examines how spaces acquire meaning and identity through their contextual and social functions (Relph, 1976; Tuan, 1977). The syntax of space enriches this analysis by assessing the spatial configurations that support or constrain social interactions and cultural activities (Hillier, 2005). In the Shiraz bazaar, place theory highlights the symbolic and sensory significance of space as perceived by users (Lak & Hakimian, 2018). The syntax of space identifies areas of high mobility and connectivity that often overlap with important cultural spaces (Hillier & Hanson, 1984). For example, spaces with high betweenness centrality may serve as focal points for social interactions and enhance their role as a "sense of place" (Lynch, 1960; Massey, 1994). By linking quantitative spatial measures with qualitative cultural insights, this integrated approach improves our understanding of how spatial configurations contribute to market identity (Hillier, 2007; Madanipour, 1996). This research will also be based on the spatial syntax

framework and will specifically use the software Depth-Map to generate quantitative data on spatial configurations. The following indicators from Depth-Map are used to analyze the impact of public buildings on the urban fabric.

Introduction of space syntax analysis parameters related to the topic and used in research based on the spatial syntax method

- Cohesion: As one of the fundamental concepts of spatial syntax, it represents spatial coherence and the degree of intertwining of a space with the whole spatial system (Didban et al., 2013). Higher values of this index indicate greater spatial integration. Cohesion is discussed at two scales. Global cohesion indicates the degree of centrality of the buildings in question at the city level, while local cohesion evaluates their accessibility in the closer range. Both of these cases determine whether these new buildings have helped to improve integration or have led to the isolation of some areas. (Hillier, 2008)
- Depth: This index measures the number of intermediate spaces that must be traversed to access from a root reference space to any other space in the system. Depth is a measure of the degree of separation of a space (Bemanian et al., 2016). Spaces with high depth require crossing a larger number of intermediate spaces for access and, as a result, are considered more topologically marginal (Khozaei Ravari et al. 2022).
- Connectivity: This index is a measure of the direct connection of a space with its adjacent and immediate spaces. Connectivity indicates the degree of connection of a node or axis with neighboring nodes in the spatial network and indicates the number of points that are directly connected to the point in question. (Çetin, & Beyhan, 2025)

The integration of Roger Transick's theories of figure-ground, connectivity, and place with the analytical method of spatial syntax in this research leads to a comprehensive theoretical and analytical framework that is able to examine the relationship between public buildings and the spatial structure of the city from various physical, functional, social, and cultural aspects. This framework not only analyzes spatial organization, urban continuity, and legibility, but also considers the impact of these relationships on social interactions, human flows, and symbolic meanings of space. The simultaneous use of the qualitative capacities of spatial design theories and quantitative methods of spatial configuration analysis—especially through the indicators provided in the Depth-Map software provides the opportunity to identify key spaces, optimize the design of public and private spaces, and detect discrete or missing areas in the urban context. This framework is particularly useful in studying the impact of the spatial organization of public buildings on urban structure during the period of physical transformations of the 14th century AH in Iran, which began with extensive interventions in cities such as Tehran, and can be used in similar case studies to deepen understanding of the spatial, functional, and cultural roles of public buildings. Thus, this analytical approach provides an effective basis for guiding future urban interventions and improving the quality of life in historical and contemporary contexts.

Methodology

This research uses a mixed approach, combining quantitative spatial analyses using spatial syntax with qualitative interpretations of historical and architectural changes in Tehran. The research will be conducted using Depth-Map software to produce spatial maps and analyze the impact of new public buildings on the surrounding urban fabric. The research type is a combination of library and fieldwork, the research orientation is applied, the research approach is inductive, the philosophical foundations of the research are based on the interpretive paradigm, its strategy is based on a case study, and the research objectives are a combination of description, understanding, and exploration, and finally the methods of collecting information through

observation and examination of documents. Data collection includes maps before and after the start of developments in Tehran, as well as architectural designs of key buildings. In the data analysis section, spatial syntax is also used in analyzing the figure-ground relationship, analyzing connections with axial line and segmentation tools, and indicators of integrity and selection for place analysis. In summary, this article, using mixed methodology and space syntax analysis tools, examines developments in various urban dimensions and analyzes the relationship between spatial structure and social behaviors, focusing on case studies.

Case Study: Tehran and the First Pahlavi Government Buildings

The first wave of Iranian modernism flourished in Tehran. Tehran was the center of modernization, the westernization of politics, and the capital of modern Iran during the Pahlavi era. As a result of the changes in the political and social system during the first Pahlavi era, the formation of new buildings and the creation of a transformation in architecture were inevitable. In such circumstances, we also witness the formation of a new figure-ground relationship. (Turner et al., 2015, Al-Said et al., 2019) During the first Pahlavi era, the construction of new streets and squares gave importance to the exterior of buildings, especially public and government buildings in the first Pahlavi era that dealt a lot with clients, were completely extroverted and had an external symbol. Therefore, in this way and over time, traditional introverted buildings were destroyed and new extroverted buildings with an external facade were built in their place. This transformation first began with the main squares and streets of the city and gradually spread to the entire existing fabric of the city. (Ghobadian, 2015) The phenomenon we are facing in this research is the change in the figure-ground relationship of public or government buildings with their urban context during the early Pahlavi era. To study the phenomenon and answer the research question, we select cases and examples. Of course, this selection is purposeful so that it reflects the subject and phenomenon in question objectively. It is obvious that the selection of samples is made from a number of public buildings of the Pahlavi era with specific criteria such as the time of construction, location (context), type of function, type of institution and users, so that we can finally obtain two samples from the types of samples in the Pahlavi era for comparison and examination.(Ünkaracalar, 2022, Çetin et al., 2020) Regarding the selection of the time of construction of the samples, the study cases were selected from the public buildings of the early Pahlavi era. Because the Pahlavi era was the beginning of extensive and fundamental changes in various aspects of Iranian society. In the Qajar era, the origin of modernization was the living environment of the courtiers and their palaces. (Turner, 2001) Until the end of this era, modernization was mainly confined to the walls of these palaces. However, with the beginning of the Pahlavi era, contact with the West and the use of Western technology to transform a traditional society into a modern society took place quickly, and modernization began to spread throughout the country. So, modernization in the Pahlavi era began in urban and public spaces. In this modernization process, the traditional form of the city of Tehran was destroyed. (Ghobadian, 2015)

Post Office Building (Communications Museum)

The Post Office Building is a large building 155 meters long and 43 meters wide. This building was designed by Nikolai Markov in 1934-1938, located in Sepah Street, near Toop-khaneh Square, south of Mashq Square, in Tehran. Toop-khaneh Square is a turning point in the design of urban squares in Iran. The reason is that Toop-khaneh Square no longer has the characteristics of historical squares in Iran, and the first new and emerging institutions and buildings and the grid of streets, which had no precedent in Iranian cities, were formed around and in connection with this square (Ghobadian, 2015, Bani Masood, 2012). The post office also has a direct

connection with the modern urban space, that is, the street. The post office institution, with an administrative function, was designed and built for public use, like most buildings of the first Pahlavi period. (Fig. 1)

Museum of Ancient Iran (National Museum of Iran)

The Museum of Ancient Iran was built between 1933 and 1937, designed by André Godard. The building is built with red bricks on the western side of the Mashq Square (National Garden) complex and at the intersection of Imam-Khomeini and 30 Tir streets. The use of red bricks and brick patterns in the museum building is reminiscent of the peak of brickwork art during the Islamic and Sasanian periods. The deep porch inspired by the Taq Kasra, the internal courtyards, the pair of columns, the multi-level display of the facade with a semicircular arch, and the hierarchical continuity of space in the depth of the building are the elements and tools used by Godard in the design of the museum (Daniel et al., 2015). (Fig. 2)

Analysis of space analysis indicators used in the research using the space syntax method

This research, using spatial layout methods, figure-ground analysis (examining the relationship between form and space), and examining historical and field documents of the site, examines the spatial configuration and impact of new public buildings built during the reform period on their surrounding urban fabric. In this study, axial analyses at macro and local scales in three different time periods have been examined with respect to the creation of urban developments and the spatial placement of case studies in order to gain a deeper understanding of how these spatial configurations affect the topological structure of the street network and urban blocks. Based on the ideas of Hillier and Hanson (1984), these constructed public buildings will affect pedestrian and vehicle movement patterns, the formation of urban centers, and the creation of urban areas with vibrant land uses. After drawing the axes based on the above-mentioned materials, each graph was entered separately into the Depth-Map software. Depth-map is a program that Space Syntax has used for research. This program can determine the depth index of points, connectivity, and the amount of correlation using an axial map and a convex map (Maroufi et al., 2014). (Fig. 3)

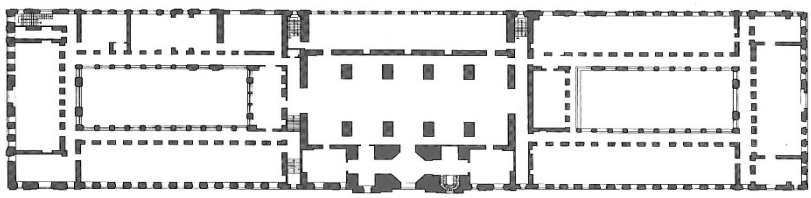


Figure 1: Post Building, ground floor plan. (Bani Masoud, 2012)

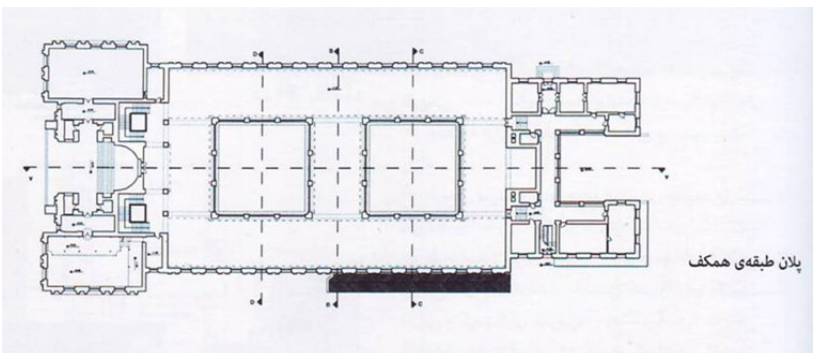


Figure 2: Museum of Ancient Iran (Daniel and et al., 2005)

Figure 3: Abdul Ghaffar's map of Tehran from the reign of Nasser al-Din Shah Qajar, source: National Library and Archives Organization of Iran

Abdul Ghaffar's map from the reign of Nasser al-Din Shah Qajar, which was prepared between 1247 and 1270 solar years

Analysis of the correlation index in the map of the Nasser-al-Din Shah era: According to the tables and images below, the findings indicate that there is a significant difference in the correlation rate of different axes of the map of Tehran during the Nasser-al-Din Shah era, meaning that the axes and areas of correlation that are seen in red and yellow on the map have the highest correlation rate and the blue and green axes show the lowest correlation rate. (Tab. 1 and 2) (Fig. 4 and 5)

Table 1: HH connectivity status at the global level

	Minimum	Average	Maximum	Std Dev
integration (HH)	0.568	1.823	3.0421	0.494

Table 2: HH concatenation status at the Local level

	Minimum	Average	Maximum	Std Dev
integration (HH)	1.10	4.35	9.49	1.11

Figure 4: HH correlation analysis at the local scale

Figure 5: HH correlation analysis at the global scale

- The results in the table on macro connectivity show a complex, layered system influenced by pre-modern Iranian cities exposed to modernization pressures. Also, unlike residential spaces that are mainly scattered in less connected areas and in blue and blue-green networks, Nasser Khosrow axis has a more complex function in the context of an urban fabric with a higher degree of connectivity. This spatial location has caused this functional element to play a role as a structural and decision-making joint in the spatial network of the city.

- The results in the table on local connectivity are based on the fact that an approximate access radius of 200 to 300 meters has been considered at the neighborhood scale. Also, examining the colors indicates that connectivity in different parts of the map tends to be yellow and green. It is worth noting that the results obtained indicate that in the Nasser Khosrow axis with orange color, the level of local connectivity was higher compared to other parts of the central fabric of Tehran.
- The stark difference between the mean macro (1.823) and local (4.35) connectivity with a relative increase of 138% indicates a structural duality in the spatial system of Qajar Tehran. This phenomenon is consistent with the pattern of compact historical cities. High local connectivity reflects efficient intra-neighborhood organization with high pedestrian accessibility (≈R3 200-300 m), indicating a city where local life dominates in many parts, neighborhoods that are connected to but not dominated by major arteries.
- The present findings support the key spatial planning hypothesis that "spatial structure is a prerequisite for social organization." Despite modernization pressures, Tehran during the era of Nasser al-Din Shah had a multilayered structure in which compact networks with high connectivity provided the basis for collective life.

Analysis of the connectivity index in the map of Nasser al-Din Shah's era:

Examining the connectivity index in the map of Nasser-al-Din Shah's era shows a significant difference between the level of connectivity in different parts. The axes and areas in the map that are seen in red and yellow have the highest level of connectivity, and the blue and green axes show the lowest level of connectivity. (Tab. 3) (Fig. 6)

Table 3: Tehran city map connectivity status during the reign of Nasser al-Din Shah

	Minimum	Average	Maximum	Std Dev
connectivity	2	78.07	498	81.83

Figure 6: Analysis of the connectivity index in the map of the era of Nasser al-Din Shah

The connectivity status in most major parts of the map is at a low to medium level and tends to be green and blue, but the main skeleton of the area, the Nasser Khosrow axis, is in the red and orange spectrum, which could be used by everyone due to its more regular connections with other points and axes and has high permeability. Areas that are often located on the periphery or in low-access points of the network may facilitate fewer social interactions. This can lead to isolation or a decrease in social capital in those parts. The connectivity index in historical studies provides a key tool for understanding the socio-spatial dynamics of cities in the past. The minimum connectivity value of 2 indicates the presence of streets with only two direct connections, which can indicate dead-end streets or streets with limited access (such as alleys leading to residential courtyards), the maximum connectivity of 498, which is related to the Nasser Khosrow axis, which indicates the key and connecting role of this axis in facilitating movement and economic activities. In addition, the average connectivity on the map is 78.07, indicating a dense and interconnected urban fabric. The dominance of blue in the connectivity index in the peripheral and central parts indicates organic growth patterns that include residential neighborhoods with narrow streets that prefer local access over macro connectivity.

The mean (78.07) and standard deviation (81.83) values indicate a relatively high dispersion of the connectivity index among the passages; that is, in addition to the central axes, a set of secondary passages with a medium to low degree of connectivity are present in the network. This has formed a hierarchical context that supports residential buildings and daily services in the urban fabric, without functionally or visually interfering with the dominant presence of public/government buildings. According to the maps and results, we find that as the level of connectivity increases, the level of connectivity also increases, indicating improved accessibility and improved readability of the map and surrounding areas.

Depth index analysis in the map of Nasser-al-Din Shah's era

Based on the image and numbers in the table, micro spaces located at greater depths mean that it is more difficult to access that micro space and to pass through spaces with lower depths to reach the desired micro space. The existence of spaces with different depths indicates a hierarchy of differences in the map. Also, based on the image obtained from the depth index analysis, the residential section located in the southwestern part of the map has the highest level of depth and the lowest level of accessibility and permeability. In addition, the predominance of blue in the map indicates the low depth in the map and the desired permeability, especially in the main streets around the buildings under study. In addition, these findings indicate a significant difference between the lowest and highest levels of accessibility at the map level.

- Spatial depth also indicates surveillance and control, the less the depth of the space, the more surveillance there will be. Also, the more layers a person passes through and the deeper the space to reach a place, the more private the feeling of space will increase.
- The dispersion of Mean-Depth values and the existence of spaces with different depths are indicative of spatial hierarchies appropriate to uses and the central importance of passages. Less depth, while improving space surveillance and control, increased accessibility and made public spaces more efficient; while greater depth indicated separation and high privacy in residential spaces. (Tab. 4) (Fig. 7 and 8)

Table 4: The status of the depth index of the Tehran city map during the reign of Nasser-al-Din Shah

	Minimum	Average	Maximum	Std Dev
Mean depth	4.213	6.896	18.217	2.150

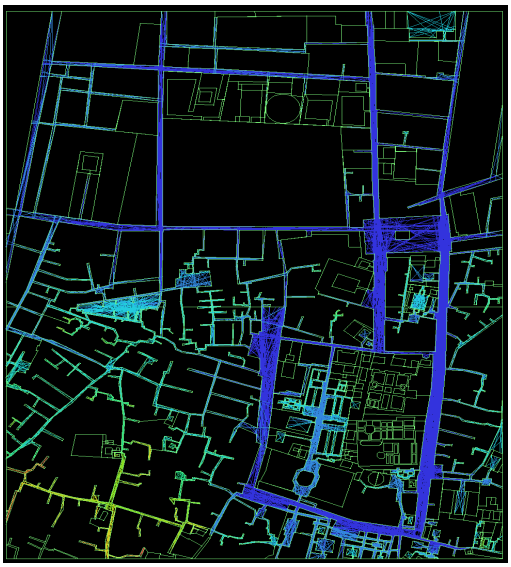


Figure 7: Depth index analysis in the map of Nasser-al-Din Shah's Era

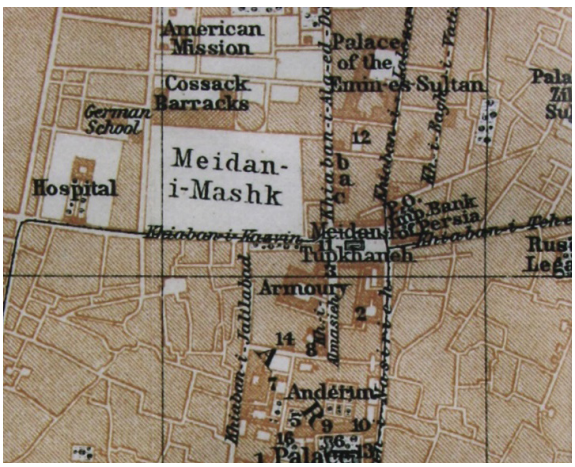


Figure 8: Map of Tehran during the Era of Ahmad Shah Qajar (Shirazian, 2016)

Map from the year 1293, which was the reign of Ahmad Shah Qajar

Analysis of the connectivity index in the map during the reign of Ahmad Shah Qajar: In order to analyze the spatial structure of Tehran in the year 1293, during the reign of Ahmad Shah Qajar, a map connectivity analysis was conducted at both macro and local scales, the results of which are presented as follows: (Tab. 5 and 6) (Fig. 9 and 10)

Table 5: HH connectivity status at the global level

	Minimum	Average	Maximum	Std Dev
integration (HH)	0.831	2.010	3.522	0.542

Table 6: HH concatenation status at the local level

	Minimum	Average	Maximum	Std Dev
integration (HH)	1.489	4.189	6.613	0.877

Figure 9: HH correlation analysis at the local level

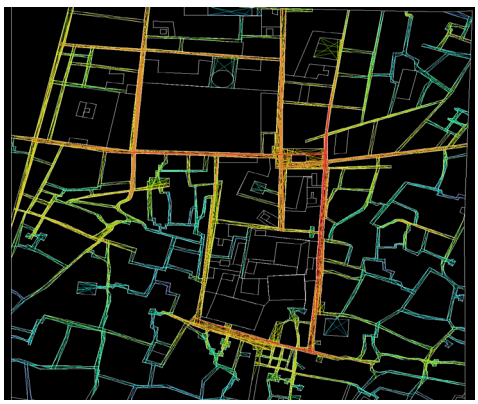


Figure 10: HH correlation analysis at the global level

In examining the connectivity at the macro level, we find:

- Toop-khaneh Square and the streets leading to it, including Nasser Khosrow Avenue and Sepah Street (today's Imam Khomeini Street), have the highest connectivity value; in such a way that these routes formed the main and comprehensive network of access and expansion of economic and social activities.
- As we approach the perimeter of the Ark and Sanglaj neighborhood, the color spectrum tends towards blue, which indicates a decrease in connectivity and a relative disconnection of these areas from the central core. This decrease in cohesion indicates that the development of secondary roads on the outskirts has not yet joined the central network.
- The average connectivity was obtained as 2.010, which indicates the average accessibility status of the entire road network. The standard deviation of 0.542 indicates a relatively limited dispersion of connectivity values; So that the maximum of 3.552 and the minimum of 0.831 indicate a relatively coherent range from very high to very low accessibility.
- The average connectivity number of 2.010 at the macro level shows that the structure of the Tehran Road network in 1293 solar year had a relative coherence and was able to establish a meaningful connection between the central and peripheral areas. Given the low standard deviation (0.542), it can be said that the design of the road network is largely uniform and the accessibility gap is limited.
- The local connectivity situation was carried out by considering an accessibility radius of 300 meters at the neighborhood scale, which yields the following results:
- The average local connectivity (1.489) indicates the average level of accessibility at the neighborhood scale. The significant range of variation (minimum = 1.489, maximum = 6.613) and relatively low standard deviation (0.877) indicate controlled spatial heterogeneity in the street network. This dispersion indicates functional differentiation of spaces without severe communication gaps.

- The spectral distribution of colors in the local connectivity map confirms the dominance of yellow to green levels in more than 60% of the central fabric. This indicates balanced spatial connections and access hierarchies without deep breaks in the structure of historical neighborhoods. However, the orange-colored focus on the Nasser Khosrow axis (with a value of 6.613) acts as a major spatial axis. This axis, with a local connectivity 40% higher than the average, played the role of a structural artery that not only had a commercial-central function, but also acted as a communication interface between peripheral nuclei. The aforementioned axis was also a product of urban modernization policies in the late Qajar period (construction of wide streets in line with historical passages), which paved the way for it to become a communication axis during the Pahlavi era.
- Spaces with high local connectivity are usually more active in terms of traffic and social interactions, attracting a higher density of pedestrians and commercial activities.

Analysis of the connectivity index in the map of Ahmad Shah Qajar's era:

This index determines the network's ability to create spatial recognition and facilitate the flow of movement during the mentioned time. (Tab. 7) (Fig. 11)

- The average connectivity of 58.462 indicates a significant level of spatial connectivity. On average, each urban space is connected to more than 58 adjacent spaces, indicating a dense and interconnected urban fabric. A feature that is common in historical Iranian cities with organic growth patterns.
- As we know, the higher the spatial connectivity (in other words, the lower the spatial depth and blind spots of the space), the more likely it is to choose that route and space for passage, which increases the readability of the axis and the space under study. Therefore, based on the findings in the Ahmad Shah era map, Nasser Khosrow axis, having the highest level of connectivity, had the highest readability in this space.
- Nasser Khosrow axis, with its reddish-orange color, as the most equitable public space, provided public access to urban functions around this axis. However, the low-connected blue spaces indicate the priority of local hierarchy and the presence of local and organic fabric in the area. Therefore, the map and numerical findings indicate the coexistence of a low-permeability local network with a high-permeability modern artery.
- By examining the images, we find that as the level of interconnection increases, the level of connectivity also increases. In other words, the level of readability or visibility from any point increases with the level of interconnection and connectivity, indicating an improvement in the accessibility and readability quality of the map and surrounding neighborhoods.

Table 7: Tehran city map connectivity status during the era of Ahmad Shah Qajar

	Minimum	Average	Maximum	Std Dev
connectivity	2	58.462	284	50.234

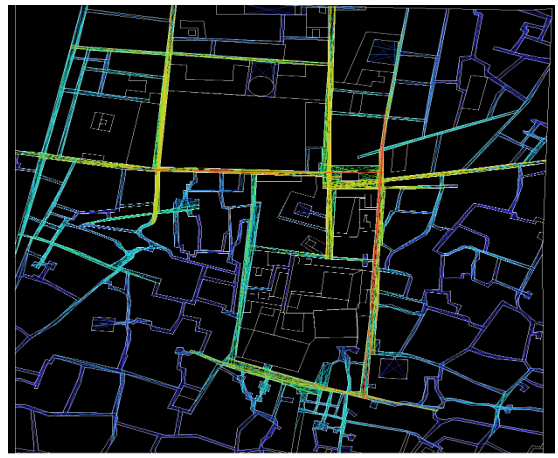


Figure 11: Analysis of the connectivity index in the map of Ahmad Shah Qajar Era

Analysis of the depth index in the map of Ahmad Shah Qajar era:

The lower depth of an area indicates its more efficient accessibility. Analysis of the depth index in the map of Ahmad Shah's reign indicates an

average of 5.780 and a relatively deep structure with the need to pass through approximately 6 nodes to access destinations. The maximum depth is 11.680, which refers to the state of depth and accessibility of marginal spaces with spatial isolation. In addition, the standard deviation of 1.430 indicates structural heterogeneity and spatial classification in the area. (Tab. 8)

Table 8: The status of the depth index of the Tehran city map during the era of Ahmad Shah Qajar

	Minimum	Average	Maximum	Std Dev
Mean depth	3.499	5.780	11.680	1.430

- Based on the findings, spaces with less depth facilitate high pedestrian flow and better socio-economic interactions. Also, in these spaces, people naturally monitor security more.
- The spatial depth structure of Qajar Tehran is not only a reflection of the Iranian "culture of privacy" but also a tangible embodiment of the power matrix in the historic city. By creating a structural distinction between government arteries (shallow) and self-sufficient neighborhoods (deep), this spatial anatomy presents a pre-modern model of the "dual city" that was radically reproduced in the Pahlavi period. (Fig. 12)

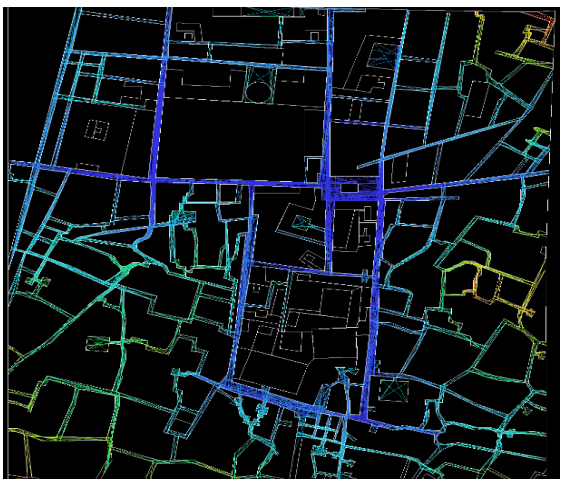


Figure 12: Depth index analysis in the map of Ahmad Shah Qajar Era

The map is from the year 1327 AH, which was the early reign of Mohammad Reza Shah Pahlavi and reflects the great urban developments during the reign of Reza Shah Pahlavi

The study of the desired indicators in the Pahlavi period was carried out entirely after the construction of both case examples, namely the post office building and the Museum of Ancient Iran.

Analysis of the correlation index in the map related to the developments during the Reza Shah era

The following results are obtained from the study of correlation at both macro and local levels resulting from the map. (Tab. 9 and 10) (Fig. 13 and 14)

Table 9: HH connectivity status at the global level

	Minimum	Average	Maximum	Std Dev
integration (HH)	1.174	2.589	4.444	0.693

Table 10: HH concatenation status at the local level

	Minimum	Average	Maximum	Std Dev
integration (HH)	1.633	5.450	8.501	1.178

Figure 13: Map of Tehran in the early days of Mohammad Reza Shah (reflecting the developments during Reza Shah's reign) (Shirazian, 2016)

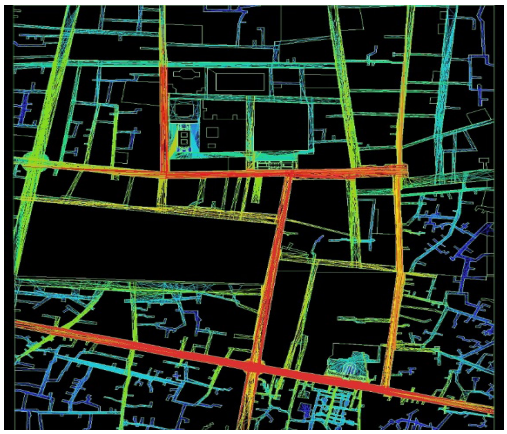


Figure 14: HH correlation analysis at the local level

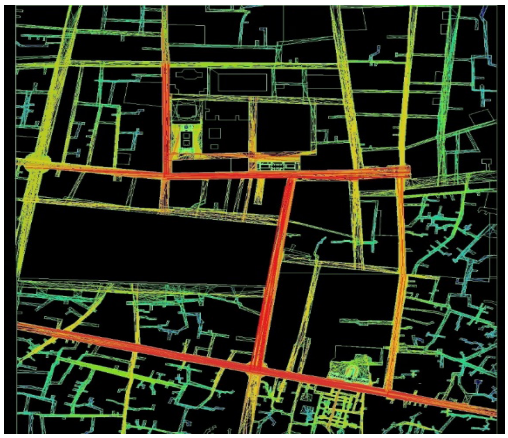


Figure 15: Global correlation analysis

- The results of examining the images and values in the table regarding the macro-level connectivity state:
- The connectivity axes and areas that are seen in red and yellow on the map have the highest connectivity rate in the area of the map of Mohammad Reza Shah's era in Tehran and are an influential factor in the formation of the activity pattern of individuals in this axis. The removal of focus from the Naser Khosrow axis and the increase in red and orange colors on Sepah, Khayyam, and Si-Tir streets are clearly visible. Naturally, after the new constructions of the Reza Shah era around Mashq Square, including the case examples in question - the post office building on Sepah Street and the Museum of Ancient Iran on Si-Tir Street - these buildings have played a significant role in increasing the connectivity rate in the area in question.
- As shown in Table 11, the connectivity range between 1.174 and 4.444 indicates that in the studied context, axes with completely different roles in the network have found meaning. This diversity shows that some of the main axes, such as Sepah Street and Khayyam Street, Si Tir Street and Naser Khosrow Street, have maximum accessibility, while others, such as alleys or side passages, are at the end of the spectrum.
- The average of 2.589 indicates that the overall level of accessibility in the urban context at that time is in the upper average range. According to previous research, in pre-industrial and post-industrial cities, the average connectivity index between 2 and 3 is evaluated as a connected texture suitable for pedestrian-oriented flows. Therefore, the urban texture of the Pahlavi era may have had an acceptable degree of spatial continuity.
- The standard deviation of 0.693 indicates that the aforementioned texture has maintained an appropriate combination of central and secondary spaces, at least in terms of overall accessibility, which has given the city desirable functional flexibility.

Analysis of the connectivity index in the map related to the era of Reza Shah's transformations

Based on the theory of spatial graphs, this index can be effective in promoting readability, democracy, and social capital. Quantitative data from the Pahlavi period indicate the connectivity status of the city map during the era of urban transformations. (Tab. 11) (Fig. 16)

Table 11: Tehran city map connectivity status during the period of Reza Shah Pahlavi's changes

	Minimum	Average	Maximum	Std Dev
connectivity	2	233.469	1399	236.147

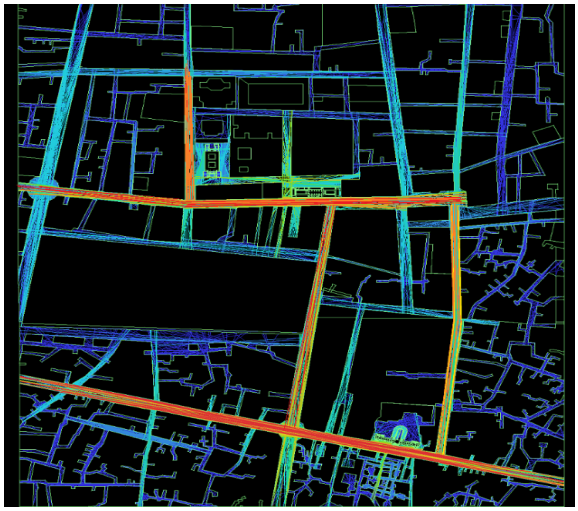


Figure 16: Analysis of the connectivity index in the map of the period of Reza Shah Pahlavi's developments

- The average connectivity of 233.469 indicates a high level of spatial connectivity in the central context of Tehran, indicating the existence of a dense and interconnected urban network. This value, which is far beyond the averages reported in many traditional historical cities, indicates a complex organization that was likely concentrated in the main axes and commercial-social centers.
- The maximum connectivity of 1399 AH, which is allocated to the axes of Sepah, Khayyam, Naser Khosrow, and 30 Tir, introduces these streets as an extremely dynamic joint and the main focus of urban activities. This value indicates the high capacity of these axes to attract pedestrian traffic, commercial interactions, and economic development potential. It is worth noting that Naser Khosrow axis had an advantage in terms of connectivity in the previous two periods, but Sepah and 30 Tir streets, and to some extent Khayyam, made significant progress in terms of measuring the connectivity index after the construction of the Post Office and the Museum of Ancient Iran - which are among the landmark buildings of the first Pahlavi period -.
- The high standard deviation of 236.147 compared to the average of 233.469 indicates a strong dispersion in the distribution of connectivity values. This huge difference (maximum 1399 versus minimum 2) indicates a polarized spatial structure. In such a pattern, we witness the simultaneous presence of spaces with very high connections (main movement centers) and spaces with marginal connections (functional dead ends). This heterogeneity is similar to the findings of studies in organic historical contexts or complex multifunctional complexes, where high-traffic public spaces coexist with semi-private or service spaces with low connectivity.
- High-connectivity spaces are prone to attracting pedestrian traffic flows and social interactions. These spaces are ideal for commercial, public, or urban landmarks. Low-connectivity spaces are suitable for uses that require tranquility (residential, specialized offices, support services) or spaces with high access control. Which is also clear from the map, are generally residential.
- Viewing images and measuring the ratio between connectivity and connectivity in the map during the Reza Shah era confirms that as the level of connectivity increases, the level of connectivity also increases, indicating an improvement in accessibility and readability of the map and surrounding neighborhoods.

Analysis of the depth index in the map of the period of Reza Shah Pahlavi's developments

Space Syntax analysis shows that layouts with higher choice values and lower step depths create stronger connections between interior residents (Hammad, Li, & Vrcelj, 2025). Relative depth, in addition to determining spatial territory, also serves as a basis for determining the degree of privacy and publicness of each space, meaning that the lower the average depth of the relative depth number, the more public the space is. The average depth of 5.537 higher than traditional organic patterns mirror the functionally differentiated modernist urbanism of this period. (Tab. 12) (Fig. 17)

Table 12: The status of the depth index of the Tehran city map during the period of Reza Shah Pahlavi's changes

	Minimum	Average	Maximum	Std Dev
Mean depth	3.461	5.537	10.318	1.217

- The low standard deviation of the depth index relative to the mean indicates a relative uniformity in the distribution of spatial depth. This is interpreted in studies of spatial layout as a sign of centralized planned design, which is consistent with the modernist urban development trend of the Pahlavi era (such as the development of wide axes and symbolic squares). This pattern is a physical manifestation of the concept of development in the early Pahlavi era, in which spatial hierarchy served political ideology.
- There is also an inverse relationship between the connectivity index and the depth index, indicating that an increase in the level of each is accompanied by a decrease in the other.

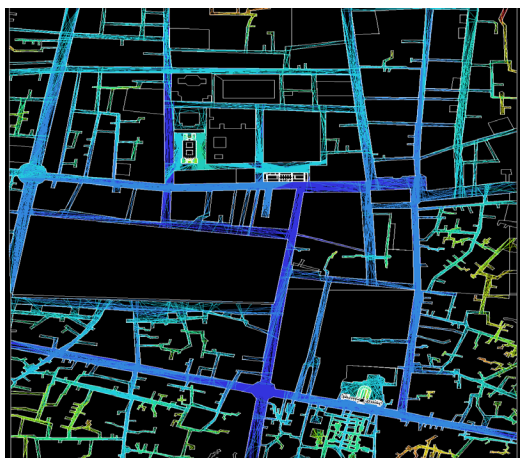


Figure 17: Depth index analysis in the map of the Reza Shah Era

DISCUSSION AND FINDINGS

During the reign of Nasser al-Din Shah, the urban fabric is quite organic and irregular; the hierarchy of axes' connectivity on a macro scale is not very prominent, and axes with high macro connectivity are limited. The relative percentage of axes with high local connectivity values indicates that intra-neighborhood interactions are strong but confined to multiple small networks. On the other hand, the moderate connectivity and relatively high depth indicate that the access routes to the central core of the city are numerous and complex. During this period, the organic texture and high depth indicate a closed and hierarchical pattern that is the product of gradual and irregular development. Spatial openness is also at its lowest level. During the reign of Ahmad Shah Qajar, signs of geometric regularization of streets and wider passages are observed; the increase in the average macro connectivity compared to the previous period indicates that the main axes are increasingly taking shape. The average local connectivity has also decreased slightly. The lower connectivity and depth indicate that the access structure has become simpler and more direct. These are the first signs of the network becoming more open and the acceptance of modern street layout patterns. Comparing the spatial layout indices of the urban transformation period during Reza Shah's reign with previous periods, we find that after the construction of the Post Office and the Museum of Ancient Iran, the macro connectivity in the studied axes, especially Sepah and 30 Tir streets, has been strengthened more than before, and these axes have been able to introduce themselves as functional axes of the city. In contrast, local connectivity and very high connectivity indicate the continuation of cohesion and dynamism at the local scale. The relative depth index has also decreased, which indicates the facilitation of the flow of movement. The Post Office and the Museum of Ancient Iran, like most public/government buildings in this period, are outward-facing and have direct connections to the street, and this combination has enabled direct interaction and the creation of semi-public spaces between them. (Tab. 13)

CONCLUSION AND RESULT

The historical cores of cities have been formed during complex developments in time and space. In the present era and with the increasing acceleration of global urbanization, the scientific confrontation with the figure-ground

Table 13: Comparison and review of changes in form and context in different periods

Periods Studied	Spatial Developments and Organization	Figure-ground Pattern	Shape Features	Background Features
Nasir-al-Din Shah	Macro interconnectedness and medium connectivity-Relatively high depth of the organic street network with limited access to the entire city- High local interconnectedness and concentration of activities at the neighborhood scale and in self-sufficient neighborhoods	Administrative buildings (e.g., Divan-khaneh) are endogenous and adapted to the fabric	The role of the "shape" (governor's buildings) does not visually or spatially dominate the "background" (urban fabric Example: Shams-ol-Emareh as a focal point, but without creating an integrated urban network	Generally inward-looking and subordinate to the context; the context takes precedence over the form%%BR%%- Organic, deep, neighborhood-centered network
Ahmad Shah	Reduction in average depth-Increased macro connectivity indicating the opening of the urban network and reduction of enclosure- Severe decrease in connectivity index likely due to incomplete lattice development or the construction of wide streets without connection to the subsidiary fabric- Local connectivity status signals strengthening of local centers in the transition to modernity	Qajar organic fabric contrasts with early chessboard patterns%%BR%%- The change factor in the background is limited, and shape and background are nearly equal	Transitional, mostly organic	-
Reza Shah	- High macro interconnectedness creating a unified city-wide network with maximum accessibility- Very high connectivity and development of an efficient grid network- Reduction of depth and increased efficiency of urban flows- Increasing standard deviation of macro and local interconnectedness indicating strong formation of spatial hierarchy	- In this period, administrative/public buildings such as post offices and the Iran-e-Bastan Museum act as the "shape" determining the organization of the "background" (fabric). Additionally, symbolic squares (e.g., Toopkhane Square) serve as nodes connecting shape and background, and public/government buildings act as urban-scale elements that influence structure and spatial arrangement	Determines the background structure and exerts influence on the spatial fabric; dominates the background	Modern integrated network and interconnected

relationship in the structure of cities is of interest and concern to urban experts. The present study was designed with the aim of identifying the spatial indicators of the historical context and explaining the social-behavioral consequences resulting from the spatial configuration of the city structure in different historical periods. Also, this study has been evaluated by selecting the historical core of Tehran during the reigns of Nasser al-Din Shah, Ahmad Shah and Reza Shah, as well as by considering the buildings of the Museum of Ancient Iran and the Post Office building as selected examples. The methodology used examines the analysis of the spatial structure and spatial arrangement of the studied areas before and after the construction of the selected examples. Finally, from the perspective of the figure-ground relationship in the three mentioned periods, we witness a transition from a completely organic and scattered

texture during the reign of Nasser al-Din Shah to a relative order during the reign of Ahmad Shah and then the creation of a modern urban network during the reign of Reza Shah. To put it more clearly, the changes in the spatial layout of Tehran from the time of Naser al-Din Shah to the time of Reza Shah show the transition from a "context-oriented city" to a "form-oriented city." In this study, quantitative findings indicate that the main and local axes of the context in the cases studied were strengthened after the construction of the post office and the Museum of Ancient Iran.

REFERENCES

Al-Said, K., Turner, A., Alsideyr, H., & Hiller, B. (2019). Methods of Research in Spatial Arrangement: Computer-aided simulation with an emphasis on the influence of morphology on human behavior in the environment (Environmental psychology in architecture and urban planning). (S. Safari, Trans.). Rasht: Rasht Branch, Islamic Azad University Publications.

Bani Masood, A. (2012). Contemporary Architecture of Iran in the Quest for Tradition and Modernity. Tehran: Naqsh-e Honar-e Me'mari-ye Qarn.

Bemanian, M., & Esfandiari, M. (2016). Typology of semi-open urban spaces in traditional Iranian cities. In Proceedings of the International Conference on Civil Engineering, Architecture, and Urban Landscape.

Çetin, A., & Beyhan, Ş. G. (2025). Space Syntax Analysis of Visual Privacy in Residential Buildings Developed Under the Influence of Modernism: A Case study in Isparta. Nexus Network Journal, 1-28

Çetin, A., Çelik, E., & Beyhan, Ş. G. (2020). Kentsel Izgara Formunun Kullanıcı Hareketlerine Etkisinin Mekân Dizim Yöntemi ile İncelenmesi Isparta Kafeler Caddesi Örneği. İdealkent, 11(31), 2034-2053.

Daniel, V., Shafaei, B., & Servoshiani, S. (2005). Niklai Markov Architecture: A collection of architectural works during Iran's transformative era. Tehran: Did Publications.

Daniel, V., Shafaei, B., & Servoshiani, S. (2015). Architecture of André Gide: A collection of architectural works during Iran's transformative era. Tehran: Victor Daniel Publications.

Didban, M., Pordiehimi, Sh., & Rismanchian, A. (2013). Relationships between "cognitive features" and "spatial configuration" of the artificial environment: An experience in Dezful. Iranian Architecture Studies, 2(4), 37–64.

Ghabadian, V. (2015). Typology and theoretical foundations in contemporary Iranian architecture. Tehran: Institute of Architectural Science.

Hammad, A., Li, M., & Vrcelj, Z. (2025). Space Syntax Analysis of Gated Communities in Jordan: Examining Urban Connectivity and Social Impact. Sustainability, 17(2), 599.

Hillier, B. (2005). The art of place and the science of space. World Architecture, 185, 96-102.

Hillier, B. (2007). Space is the machine: a configurational theory of architecture. Space Syntax.

Hillier, B. (2008). Space and spatiality: what the built environment need from social theory. Building research & information, 36(3), 216-230.

Hillier, B., Burdett, R., Peponis, J., & Penn, A. (1986). Creating life: or, does architecture determine anything? Architecture & Comportement/Architecture & Behaviour, 3(3), 233-250.

Hillier, B., Hanson, J., & Peponis, J. (1984). What do we mean by building function? E & FN Spon Ltd.

Khozaei Ravari, Z., Ul Islam, Q., Khozaei, F., & Choupan Zarvijani, S. B. (2022). Factors that hinder the thesis writing process of non-native MA students in ELT: supervisors' perspectives. Journal of Applied Research in Higher Education, 15(5), 1325-1336.

Lak, A., & Hakimian, P. (2018). A new morphological approach to Iranian bazaar: The application of urban spatial design theories to Shiraz and Kerman bazaars. Journal of Architectural Conservation, 24(3), 207–223.

Lynch, K. (1960). The image of the city. MIT Press.

Madanipour, A. (1996). Design of urban space: An inquiry into a socio-spatial process. Wiley.

Maroufi, H., Bamian, M., & Yeganeh, M. (2024). Spatial behavior dimensions in the formation of living spaces: A case study of Meybod City. Geography Quarterly (Regional Planning), 14(55), 486–504.

Massey, D. (1994). Space, place, and gender. University of Minnesota Press.

Relph, E. (1976). Place and place lessness. Pion Publications

Shirazian, R. (2016). Tehrano-graphy: A bank of maps and toponyms of old Tehran. Tehran: Dastan Publications.

Trancik, R. (1986). Finding Lost Space: Theories of Urban Design. John Wiley & Sons

Tuan, Y. F. (1977). Space and place: The perspective of experience. University of Minnesota Press.

Turner, A. (2001). Depthmap: a program to perform visibility graph analysis. In Proceedings of the 3rd international symposium on space syntax (Vol. 31, pp. 31-12). Atlanta, GA, USA: Georgia Institute of Technology.

Turner, S., Sider, P., Pinlo, J., & Khoao, D. (2015). Introduction to Depth Map software. (S. Samavati, S. Mehrabi, M. Mehrabi, & F. Mehrabi, Trans.). Tehran: Shaparak Sorkh Publications.

Ünkaracalar, S. S. (2022). Changing urban forms, spatial perceptions, and relations: A spatial urban reading of Sıhhiye, Ankara (Master's thesis, TED University (Turkey).