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Caravanserai as Semi-nodal Spatial-Economic Elements in the Urban Structure of Tabriz's Historical Bazaar: A Morphological Analysis Based on Spatial Syntax

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Abstract

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The historical bazaar of Tabriz represents a complex urban-commercial system shaped by long-distance trade networks connecting Iran to Anatolia, the Caucasus, and Central Asia. While previous studies have mainly examined their architectural and socio-economic features, the spatial role of caravanserais in the internal bazaar network has not been adequately explored.

This study examines the spatial location of caravanserais in the bazaar structure using a hybrid approach that combines morphological analysis and spatial syntax techniques. Caravanserais were assessed in terms of their integration, connectivity, and proximity to major intersections and movement corridors.

The findings indicate that caravanserais are mainly located along highly integrated routes and close to key intersections, although they do not consistently coincide with syntactic nodes.

This study argues that caravanserais function as semi-nodal spatio-economic elements that reinforce movement patterns and trade hierarchies, rather than independently creating them.

This research contributes to urban morphology and heritage studies by providing a measurable interpretation of traditional bazaar systems and advocating for their sustainable integration into contemporary urban contexts.

Keywords: Tabriz Bazaar, Caravanserai, Urban Morphology, Space Layout, Spatial Network, Integration, Connection.

1. Introduction

Traditional bazaars have long served as the economic, social, and spatial cores of cities in Central Asia and the Middle East (Bonine, 1989; Madanipour, 2003). Unlike modern commercial environments, these bazaars are not simply places for the exchange of goods, but rather complex urban systems in which economic transactions, social interactions, and cultural practices are embedded in a coherent spatial structure (Smith, 2023; Reicher et al., 2025). The spatial organization of traditional bazaars is the result of a gradual and evolutionary process shaped by economic flows, environmental conditions, and social organization. These bazaars developed not as pre-designed complexes but through interconnected commercial networks, guild systems, and the organic growth of the city (Kheirabadi, 1991). As a result, they are examples of flexible and adaptable spatial configurations that are able to respond to local and transregional dynamics.

Beyond their economic role, traditional bazaars can also be analyzed from the perspective of place theory. According to Relph (1976), place is not simply a physical location, but a meaningful combination of spatial form, human activity, and cultural value. From this perspective, the Iranian bazaar is a prominent example of a “place” in which spatial organization and social and economic functions are deeply intertwined. In contrast, contemporary commercial spaces, especially modern shopping malls, have often developed as introverted systems that are disconnected from the urban context, weakening spatial continuity and creating a state of placelessness (Newman et al., 2021).

The traditional Iranian bazaar generally has a linear structure that acts as the backbone of the city and extends towards the main city gates (Soltanzadeh, 2001). This spatial organization is mainly composed of rows; covered passageways formed by two parallel rows of shops that organize the main system of movement and access to the bazaar. At the intersection of these rows, the squares appear as important points of spatial focus and reinforce the spatial hierarchy of the bazaar.

Within this structure, caravanserais have a distinct place and specific function. In contrast to rows, which are responsible for directing continuous movement, caravanserais are organized as introverted courtyard-centered spaces designed to accommodate merchants, store goods, pay taxes, and facilitate business negotiations (Kiani, 1989). Their architectural form created a semi-controlled environment that, while directly connected to the main routes of the bazaar, maintained its internal functional independence. In cases where direct entry of caravans was not possible, these spaces were organized as sera, while commercial spaces with higher value and richer architecture were formed as timche (Rastiemadabadi & et al., 2025). Historically, caravanserais in Tabriz were strategically built near the entrances to the bazaar and adjacent to the

main city gates to facilitate the entry of trade caravans. Due to the large number of animals carrying goods and the need for health, tax, and customs controls, goods first entered the caravanserais and, after being inspected and organized, were allowed to enter the main bazaar network (Rashid al-Din, 1940; Ibn Akhuwwa, 1981).

This shows that the caravanserais functioned not as central public spaces but as intermediate infrastructures between the external trade network and the internal structure of the bazaar.

Historical sources clearly demonstrate the special importance of the caravanserais in Tabriz. During the Safavid period, Tabriz had between 200 and 300 caravanserais, which was much more than in cities such as Isfahan, Qazvin, Kashan, and Yazd. Many of these caravanserais had the capacity to accommodate hundreds of merchants and travelers, indicating their key role in regional and international trade. This historical evidence confirms that caravanserais should not be interpreted as the main generators of urban growth, but rather as semi-nodal spatial-economic elements that reinforced existing trade flows, stabilized bazaar functioning, and connected the external trade network to the internal spatial logic of the bazaar. The Tabriz Historical Bazaar Complex, which is registered on the UNESCO World Heritage List (UNESCO, 2019), provides a suitable context for examining this issue. As one of the largest and most complex covered bazaars in the world, this bazaar has a multi-axial and hierarchical structure that connects *rastehs*, *timchehs*, mosques, and caravanserais in a continuous spatial network.

The aim of this research is to examine the spatial role of caravanserais in the structure of the Tabriz Historical Bazaar. Using a network-based analytical framework and measurable indicators such as Integration and Connectivity, this study analyzes the relationship between the location of caravanserais, movement patterns, and spatial accessibility. The main research question is whether caravanserais act as main generators of urban movement and growth or as semi-nodal spatial-economic elements embedded in the existing spatial structure.

The research hypothesis is based on the premise that caravanserais are not the main nodes of the bazaar spatial configuration, but rather function as semi-nodal spatial-economic elements whose importance stems from their proximity to highly integrated routes, their intermediate depth in the network, and their capacity to enhance commercial clustering and spatial stability.

Historical urban forms that remain active are a valuable source of knowledge that reflect accumulated spatial practices, socio-economic interactions, and long-term processes of adaptation. These environments serve not as models for direct reproduction, but as a platform for understanding how spatial systems evolve in response to changing cultural, economic, and environmental conditions (McGill, 2023; Geddes, 1915). In this regard, the study of historical urban structures provides a fundamental framework for understanding the relationship between spatial configuration and urban life (Keshavarzian, 2009).

1.1 The Iranian Bazaar as an Urban-Spatial System

The term bazaar (*bāzār*) literally means “place of prices” and historically refers to the public bazaar area of Iranian cities (Bonine, 1989; Soltanzadeh, 2001). Over time, the concept has spread across different cultures and languages, while largely retaining its original meaning as a permanent bazaar. However, beyond this basic definition, bazaar represents a complex form of public space that extends beyond individual shops or stalls and often encompasses entire commercial neighborhoods composed of interconnected spatial, economic, and social elements (Madanipour, 2003; Keshavarzian, 2007). In Iranian cities, bazaars developed as complex urban-spatial systems through the gradual accumulation of commercial and public buildings along major trade routes (Kheirabadi, 1991). Rather than being designed as discrete commercial entities, they organically emerged through commercial networks. In conjunction, guild systems and continuous urban growth evolved. Their spatial organization usually followed one or more linear axes that connected the main urban elements such as city gates, central squares, and mosques. In this structure, the *rastah* served as the main circulation backbone, integrating commercial, religious, and service spaces into a continuous network of movement (Figure 1).

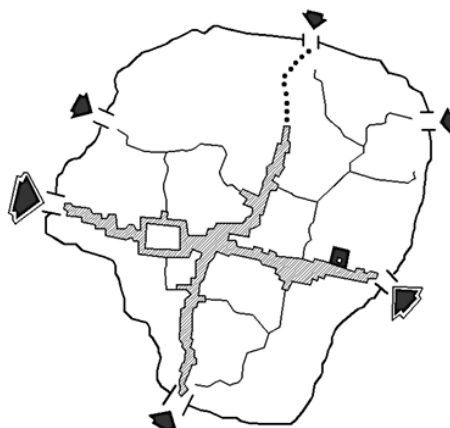


Figure 1. The spatial integration of Tabriz Bazaar into the urban structure, showing its role as a major east-west commercial axis connecting the city's main gates and urban areas (Golkarian, 2021a).

The intersection of these main routes forms the Chaharsouq, which act as focal points of spatial convergence and intensification of urban activity. Other elements such as caravanserais, serais, and *timchehs* are embedded in this system

and contribute to the hierarchical organization of movement, trade, and social interaction. While the order facilitates linear movement and high levels of access, these enclosed spaces offer varying degrees of spatial control and functional specialization, reflecting differences in ownership, use, and socio-economic roles (Madanipour, 1996; Yadollahi, 2017). Therefore, the bazaar should not be understood through a simple public-private dichotomy, but rather as a structured spatial spectrum with access, control, and function. Highly integrated public spaces such as *rastehs* sit alongside semi-controlled spaces such as *caravanserais* and *timchehs*, creating a layered system in which movement and economic activity are highly intertwined. This complexity allows the bazaar to function simultaneously as a commercial infrastructure, a social gathering place, and a cultural institution. Historically, the bazaar served as the structural and functional core of the Iranian city, shaping patterns of urban growth and supporting economic and social life (Kostof, 1991; Keshavarzian, 2007). As the backbone of the traditional city, it organized circulation, centralized exchange activities, and linked different urban functions into a coherent spatial hierarchy. However, during the twentieth century, processes of modernization, institutional transformation, and rapid urban expansion transformed the relationship between the bazaar and the broader urban system. New streets, modern commercial typologies, and changing economic structures have gradually reduced the spatial and economic centrality of the bazaar without eliminating its physical presence (Rouz, 2014; Yadollahi, 2017). Despite these transformations, the Iranian bazaar remains one of the most important examples of an adaptable urban form. Its continuity demonstrates how traditional urban systems maintain their continuity while responding to changing economic, political, and social conditions. This adaptability is rooted not only in the flexibility of its architecture but also in the relational structure of its spatial organization, where circulation corridors and enclosed commercial spaces function together as a coherent urban network.

Unlike the *rasteh*, which primarily organizes movement and access, the *caravanserai* introduces a more centralized spatial logic into the bazaar system. It concentrates economic functions in an introverted courtyard structure and creates local centers of exchange connected to the larger circulation network. While the order distributes movement, the *caravanserai* attracts and stabilizes activity. The interaction between these two elements is fundamental to understanding how movement corridors transform into sustainable commercial clusters and how they structure the internal morphology of the bazaar (Jamei et al., 2021).

1.2. Caravanserai as Spatial-Economic Elements in Iranian Bazaars

Caravanserais are among the most important spatial and economic elements in the structure of traditional Iranian bazaars. Although often described in historical sources as spaces for temporary accommodation of merchants, caravans, and storage of goods, their role goes far beyond a simple service infrastructure. In the major commercial cities of Iran, *caravanserais* functioned as enclosed commercial complexes that supported a wide range of activities, including warehousing, wholesale exchange, negotiation, accounting, and the organization of commercial networks. Their spatial organization, usually formed around a central courtyard surrounded by rooms and commercial units, made them suitable for both logistical and commercial functions (Soltanzadeh, 2001; Kiani, 1989; Bonine, 1989).

In the formation and development of Iranian commercial cities, *caravanserais* played an important role in strengthening the concentration of economic activities and consolidating urban centrality. These spaces were usually located along the main trade routes and in the vicinity of the most active bazaar corridors, allowing them to benefit directly from the flow of goods, merchants, and commercial exchanges. Their density and distribution in large Iranian cities demonstrate the close relationship between interregional trade, the expansion of bazaar structures, and the physical growth of urban form. In this context, although *caravanserais* cannot be considered the main generators of urbanization, they should be understood as key elements in organizing and reinforcing trade-based urban development (Soltanzadeh, 2001; Keshavarzian, 2007).

From a spatial-morphological perspective, *caravanserais* occupy an intermediate position in the bazaar structure. They are generally connected to the main routes through controlled entrances and maintain a relatively independent and semi-private internal spatial organization. This dual status places *caravanserais* on the border between public circulation systems and semi-controlled economic environments. While the order organizes continuous pedestrian movement and high accessibility, the *caravanserai* concentrates economic activity in an enclosed courtyard structure that supports storage, negotiation, and controlled exchange.

This spatial duality makes *caravanserais* mediating elements between movement and commerce. Their importance lies not only in their architectural presence, but also in their relational function within the wider bazaar network. They provide the spatial conditions through which movement corridors become stable commercial clusters, allowing for simultaneous accessibility and functional specialization.

Within a theoretical framework based on spatial configuration and network analysis, the location of *caravanserais* can be interpreted as a defining feature of their function. Their proximity to highly integrated routes, combined with controlled internal access, suggests that they do not function as completely autonomous central nodes. Instead, they function as semi-nodal elements whose importance derives from their relational position within the larger urban system. Their role emerges through interaction with movement flows, economic processes, and functional dependencies, not simply through configurational centrality.

This interpretation places *caravanserais* at the intersection of spatial configuration and economic strategy, where access, interaction, and commercial efficiency are simultaneously optimized. They do not generate movement independently, but rather absorb, stabilize, and structure existing flows. In this sense, *caravanserais* should be understood as spatio-economic interfaces that connect highly integrated circulation systems with local centers of commercial exchange.

Unlike contemporary shopping malls, which often function as introverted and isolated commercial systems detached from the surrounding urban context, traditional *caravanserais* function as integral parts of a larger place-based urban network. Their spatial logic lies in the continuity of the bazaar and the broader urban structure. Therefore, *caravanserais* should not

be interpreted simply as architectural entities, but as active components of a networked spatial system that contributes to urban continuity, economic clustering, and place continuity. Accordingly, this study adopts an integrated theoretical framework that combines spatial configuration theory (Hillier, 1996), urban morphology (Kropf, 2017), and socio-spatial production (Lefebvre, 1991). Spatial configuration provides a quantitative basis for the analysis of movement and access, urban morphology offers a structural understanding of spatial organization and transformation, and socio-spatial theory enables the interpretation of the relationships between space, economy, and social practice (Karimi, 2023; Jiang, 2007; Porta et al., 2006). Together, these perspectives support a comprehensive analysis of caravanserais as spatial-economic elements embedded in the Iranian bazaar system.

2. Materials and Methods

This study uses a quantitative spatial analysis based on spatial syntax theory to examine the role of caravanserais in the configuration structure of the historical bazaar of Tabriz. The analysis was conducted using DepthmapX, focusing on the relationship between spatial configuration and movement patterns.

The base map was taken from digital plan data obtained from the Iranian Cultural Heritage Organization (ICHHTO, 2019), which was redrawn to represent the accessible circulation network of the bazaar. An axial map was created to model the longest lines of sight and movement, ensuring that all main and accessible routes were considered and unnavigable spaces were eliminated.

A global-scale spatial analysis was conducted using integration (R_n) as the main criterion to capture overall accessibility in the system. Complementary criteria, including connectivity and average depth, were also calculated to assess local spatial relationships and hierarchical organization of the network.

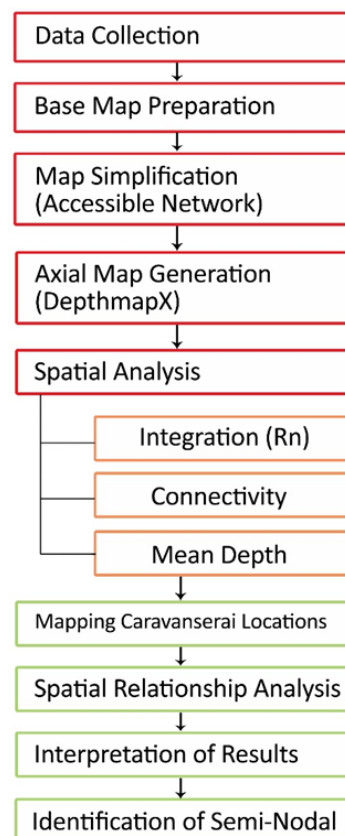
Caravanserais were identified as fixed spatial elements and mapped onto the axial grid. Their spatial role was assessed based on their configurational position relative to highly integrated routes, their connectivity levels, and their depth in the system. This approach allows for the assessment of whether caravanserais function as primary nodes, secondary elements, or intermediary components in the spatial hierarchy.

To ensure analytical validity, the axial model was manually verified for coherence and completeness. Although simplification of the urban context was necessary, the resulting model provides a reliable representation of the bazaar's movement structure.

In addition to configurational analysis, a morphological approach was used to examine the relationship between built form and open space. This involves the use of shape-field (shape-diagram) analysis following the transect, which supports the interpretation of spatial patterns and structural relationships in the bazaar (Paikan & Mohammadiya, 2025).

This research uses a mixed quantitative and qualitative methodology. While spatial layout provides measurable indicators of spatial configuration, qualitative interpretation, supported by field observations and secondary data sources, enables a deeper understanding of the functional and socio-economic roles of caravanserais in the bazaar system. Overall, the methodological framework is designed to interpret the bazaar not only as a historical-commercial environment, but also as an integrated spatial system in which access, movement, and economic function are closely linked (Table 1).

Table 1. Conceptual Framework of the Study (Developed by author).



3. Study Area

3.1 Background of Tabriz Bazaar

The historical bazaar of Tabriz is one of the largest and most complex covered bazaars in the world, inscribed on the UNESCO World Heritage List in 2010 (UNESCO, 2019). Historically, the bazaar has served as the economic, social, and cultural core of Tabriz and has played a decisive role in organizing the urban structure (Bonine, 1989; Madanipour, 2003). The roots of the formation of the Tabriz bazaar go back to the city's strategic location at the intersection of important regional and trans-regional trade routes. The city developed as a key node in historical trade networks, especially in connection with the Silk Road routes (UNESCO, 2019; Yadollahi, 2017).

The historical development of the Tabriz bazaar reflects a gradual and organic growth pattern that has developed over time in response to economic, social, and urban needs. Unlike planned commercial spaces, this bazaar has developed through the gradual accumulation of commercial, religious, and service spaces along the main urban routes, becoming a complex and integrated spatial system (Figure 2), (Soltanzadeh, 2010).

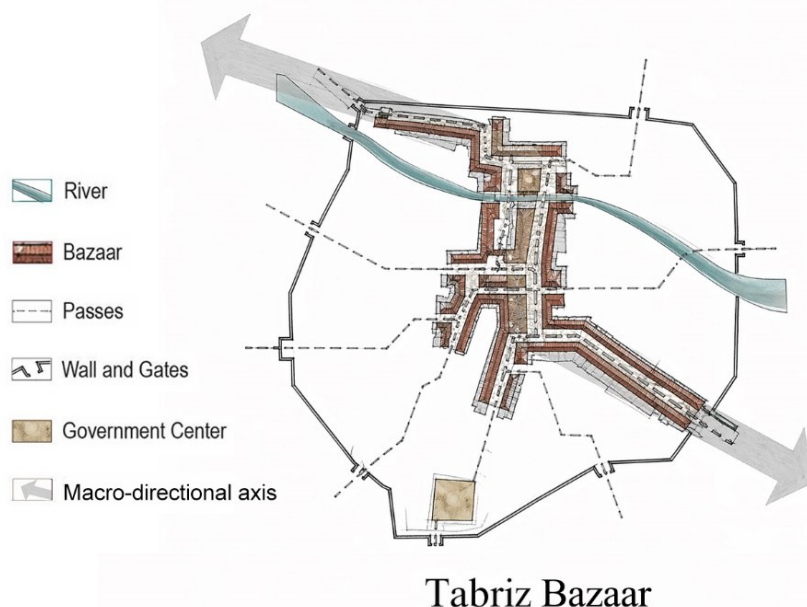


Figure 2. The spatial location of Tabriz Bazaar as the main urban backbone, showing its connection to the city's main gates in the 18th century (Drawn by the author).

In this process, key elements such as caravanserais, sarahas, and timchehs emerged as complementary components of the bazaar structure and played an important role in supporting commercial activities, especially intercity trade (Kiani, 1989; Soltanzadeh, 2008). This shows that the Tabriz bazaar was not an isolated space, but an interconnected urban system that was closely connected to the network of streets and public spaces around it, (Figure 3).

During the Seljuk period, the central core of the bazaar was formed around the Jame Mosque. During the Ilkhanid period, the main commercial focus shifted to the Sham Ghazan neighborhood, and the expansion of the bazaar moved southwestward. Under the patronage of Khwaja Rashid al-Din Fazlullah, the Rabe Rashidi complex included extensive commercial and service infrastructure, including shops, caravanserais, mosques, schools, baths, dyeing workshops, a printing house, and a papermaking workshop. This suggests that the development of the bazaar was closely linked to broader systems of trade, production, education, and urban services.

In later periods, the spatial orientation of the bazaar continued to change. During the Qara-Quyunlu period, the construction of the Blue Mosque changed the physical orientation of the bazaar to the southeast. During the Aq-Quyunlu period, the construction of the Hassan Padashah Square and Mosque encouraged expansion to the north and northeast. This northerly orientation continued during the Safavid period, particularly with the development of Sahibabad Square and related urban spaces. After the 1193 AH earthquake, the bazaar and urban fabric were rebuilt during the reign of Najaf Qoli Khan, reinforcing the bazaar's central role within the city.

However, in the 20th century, modern urban interventions disrupted parts of this historical continuity. The construction of new streets, especially Shah Bakhti Street, divided the bazaar's central core and separated some of the historical commercial axes from the main bazaar structure. As a result, some of the former entrance axes and peripheral bazaars gradually lost their direct connection with the main bazaar and became more local commercial spaces (Figure 4). This transformation changed access patterns and weakened the spatial continuity between the historic bazaar and the surrounding city.

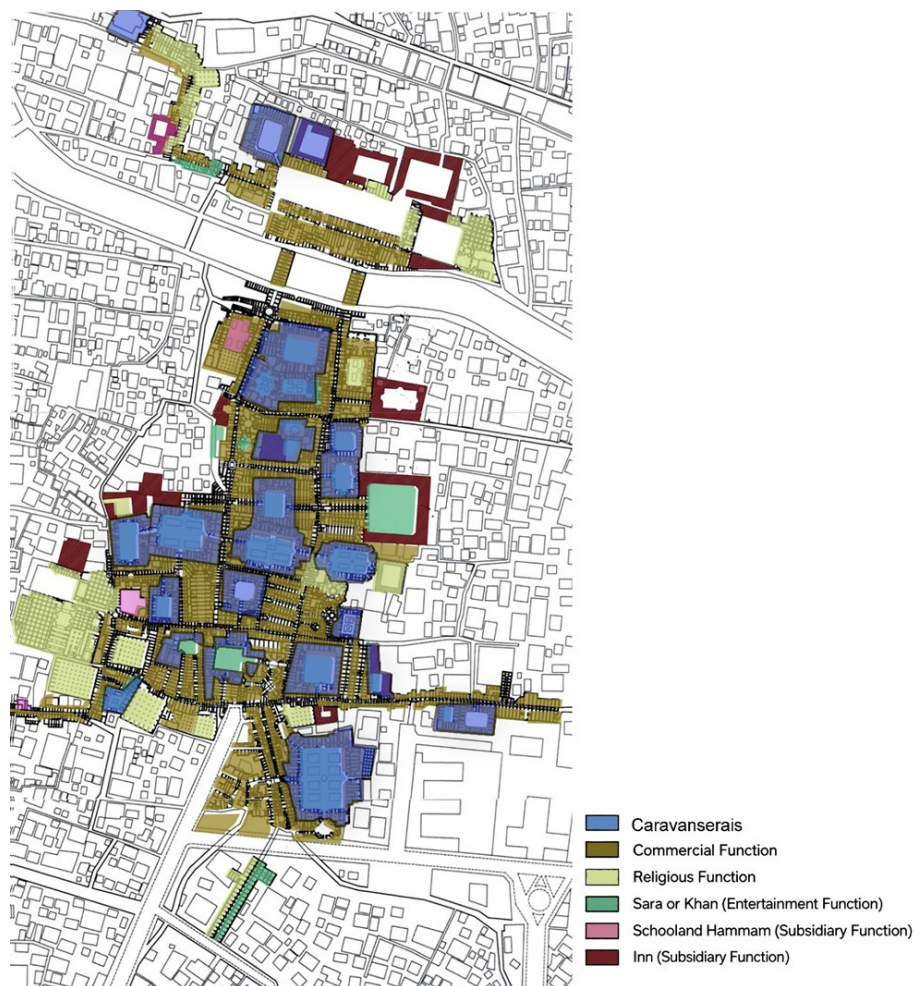


Figure 3. Spatial distribution of functional areas in Tabriz Bazaar, highlighting the relationship between spatial accessibility and economic activities (drawn by author).



Figure 4. Shape-field map of Tabriz Bazaar and its surrounding urban fabric, showing the spatial density, morphological continuity, and hierarchical organization of the bazaar in the city structure (Drawn by the author).

3.2 Spatial Structure of Tabriz Bazaar

The spatial configuration of Tabriz Bazaar reflects a networked, hierarchical, and group-cellular structure that has been formed through the gradual accumulation of spaces around the main axes (Golkarian, 2021b). In this structure, the rows act as the movement backbone, and spaces such as timchehs, serahs, and caravanserais are organized in relation to these axes (Figure 5). This configuration strengthens the spatial continuity between the internal structure of the bazaar and the surrounding urban context, simultaneously establishing the bazaar as a commercial core and an urban interface.

Despite the relative preservation of the physical structure of the bazaar, contemporary urban developments have led to changes in the patterns of access and distribution of economic activities. The creation of new streets and the development of modern infrastructure have shifted the focus of economic activities to areas with higher accessibility and reduced the intensity of activity in the deeper spaces of the bazaar. This process has led to the formation of a kind of spatial-economic differentiation in the bazaar (Golkarian, 2021b; Yadollahi, 2017).

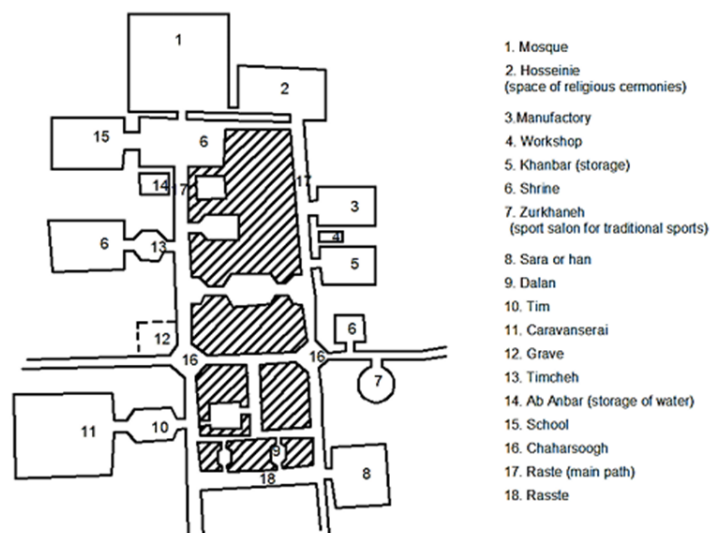


Figure 5. Schematic diagram of the spatial and functional organization of a traditional Iranian bazaar, showing the relationships between the main routes (routes), caravanserais, timchehs, and supporting socio-religious spaces (Soltanzadeh, 2001).

This spatial organization follows a hierarchical system that includes:

- Main axes (rows) with the highest level of accessibility
- Secondary routes as spatial connectors
- Nodal spaces such as caravanserais and timchehs.

This structure allows for efficient movement, distribution of commercial activities, and the formation of diverse patterns of social interaction, (Figure 6), (Figure 7).

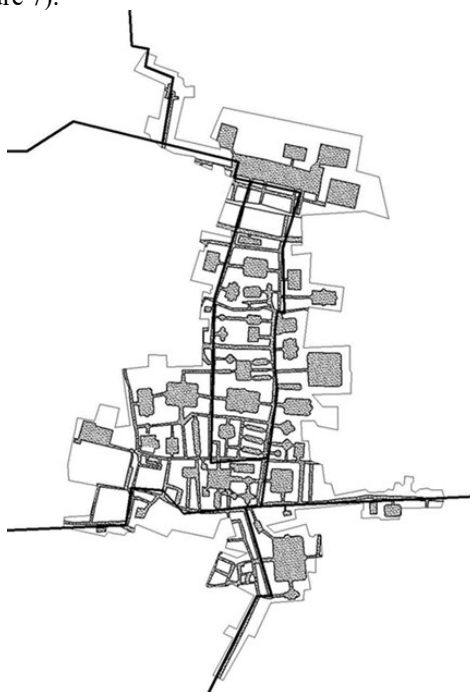


Figure 6. The cell-group structure of the Tabriz bazaar shows the organization of spatial clusters around the main circulation axes, (Soltanzade, 2001).

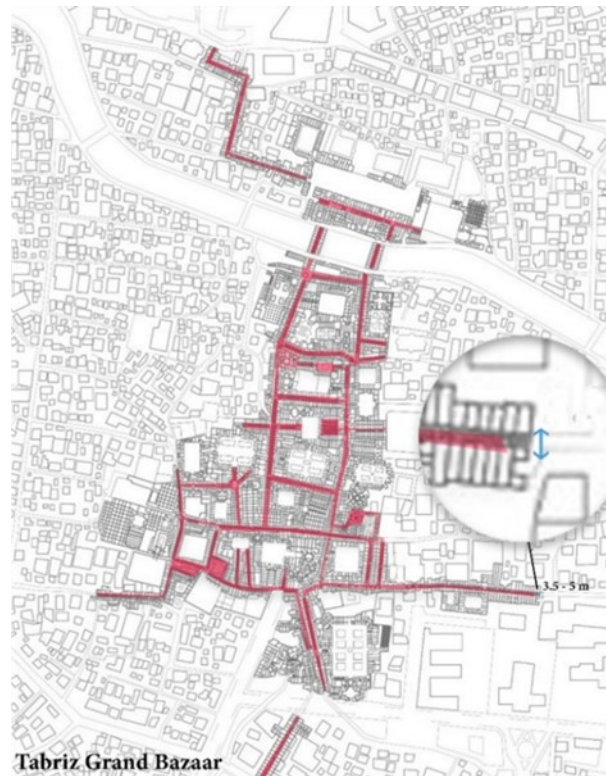


Figure 7. The spatial network and access structure of Tabriz Bazaar shows the hierarchy of main and secondary routes and their integration with the surrounding urban fabric (Golkarian, 2025).

3.3 Caravanserais of Tabriz Bazaar

Caravanserais were the most important commercial and logistical elements of the Tabriz bazaar. Historically, they served as spaces for merchants to reside, store goods, exchange wholesale, and organize trade networks. In urban contexts, the terms caravanserais, sera, and khan were often used to describe large courtyard-like commercial complexes where merchants and caravans resided, traded, and stored their goods. Over time, especially after the decline of caravan transport and the advent of wheeled and motorized vehicles, the term sera gradually replaced caravanserais in many urban contexts, (Figure 8), (Figure 9).



Figure 8. Spatial distribution of caravanserais in Tabriz Bazaar, emphasizing their integration into the movement network and their role as intermediary spatial elements, (Soltanzade, 2001).

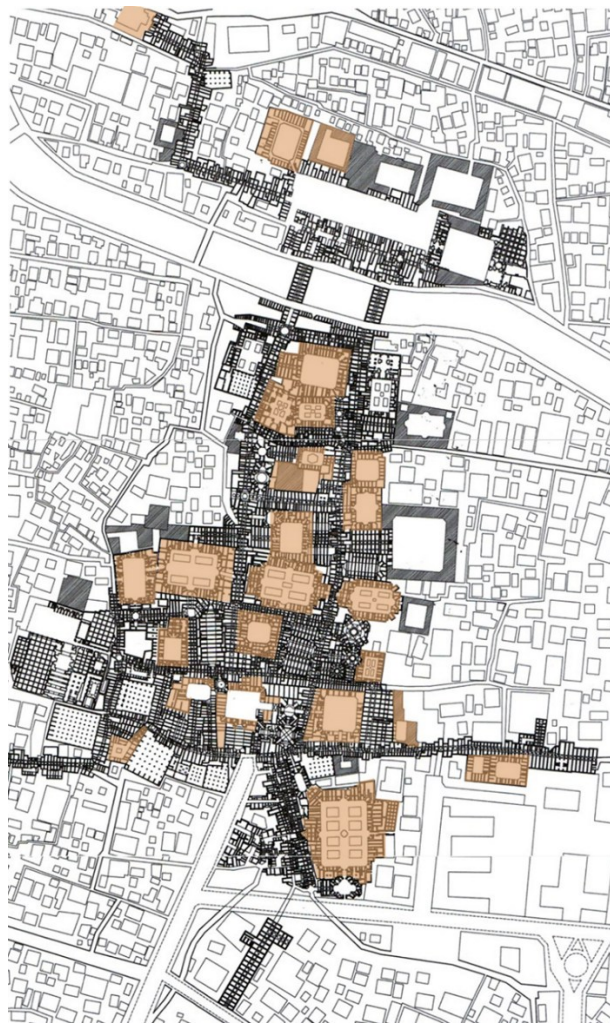


Figure 9. Caravanserai in Tabriz Bazaar (Drawn by the author).

In Tabriz, caravanserais played a pivotal role in connecting external trade routes with the internal structure of the bazaar. They were often located near the bazaar entrances, along the main commercial axes, or behind rows of shops connected by rows. This location allowed goods entering the city to be stored, cleaned, taxed, and redistributed before reaching the main bazaar. In this sense, caravanserais functioned as intermediary infrastructures between long-distance trade and the bazaar's internal trade network. Historical accounts emphasize the exceptional number and importance of caravanserais in Tabriz. During the Safavid period, the city reportedly had between 200 and 300 caravanserais, far more than many other major Iranian commercial cities. Some of these caravanserais were large enough to accommodate hundreds of merchants, travelers, animals, and goods. This scale confirms Tabriz's importance as a major center of regional and international trade. In Figure 10, the spatial pattern shows that the Tabriz Bazaar is not a closed and isolated complex, but an open and interconnected urban system that is directly connected to the city structure through multiple entrances. The rows act as the backbone of the bazaar's movement and direct the main flow of movement, while spaces such as caravanserais, sarahas, and timchehas are formed along these axes and near the intersection points.

The spatial organization of the caravanserais in the Tabriz Bazaar also reflects their functional diversity. Some caravanserais, such as the Saray-e-Amir and the Saray-e-Haj Seyyed Hossein Jadid, had three or four entrances and multiple access routes, indicating their stronger connection to the main movement flows of the bazaar. In contrast, caravanserais such as the Mirza Mehdi House, the Jafariyeh House, the Seyyed Hossein Miyaneh House, and the Mirza Shafi House had two or even just one entrance and functioned more as introverted, controlled spaces for more specialized activities such as warehousing, wholesale trade, and commercial negotiations. This difference in the number of entrances suggests that not all caravanserais occupied the same position in the spatial hierarchy of the bazaar. Caravanserais with greater access played a more active role in attracting and distributing trade flows, while those with more limited access were more dedicated to stabilizing and controlling economic activities. From this perspective, caravanserais can be viewed as semi-nodal elements in the bazaar structure, whose function derives not from absolute centrality but from their relational position in the spatial network. Also, the morphological changes of some caravanserais over time indicate that these spaces were not fixed and static structures. In cases such as the Gurjiler Palace and the Grand Prince Palace, economic development has reduced or eliminated the central courtyard and replaced it with new rows of shops. This indicates the physical flexibility of the caravanserais and their ability to adapt to changing bazaar needs. The relationship between caravanserais and timchehs also forms an important part of this spatial organization. Timchehs, as covered and often linear spaces, are often located between two main or secondary rows and have two access routes. The combination of these covered spaces with the courtyard-oriented structure of the caravanserais creates a coherent spatial-commercial system in which movement, exchange, storage, and economic interaction are organized simultaneously. Therefore, this

image not only shows the bazaar's movement network, but also reveals the logic of the placement of caravanserais; where access, control, and economic function together shape the spatial structure of the Tabriz bazaar.

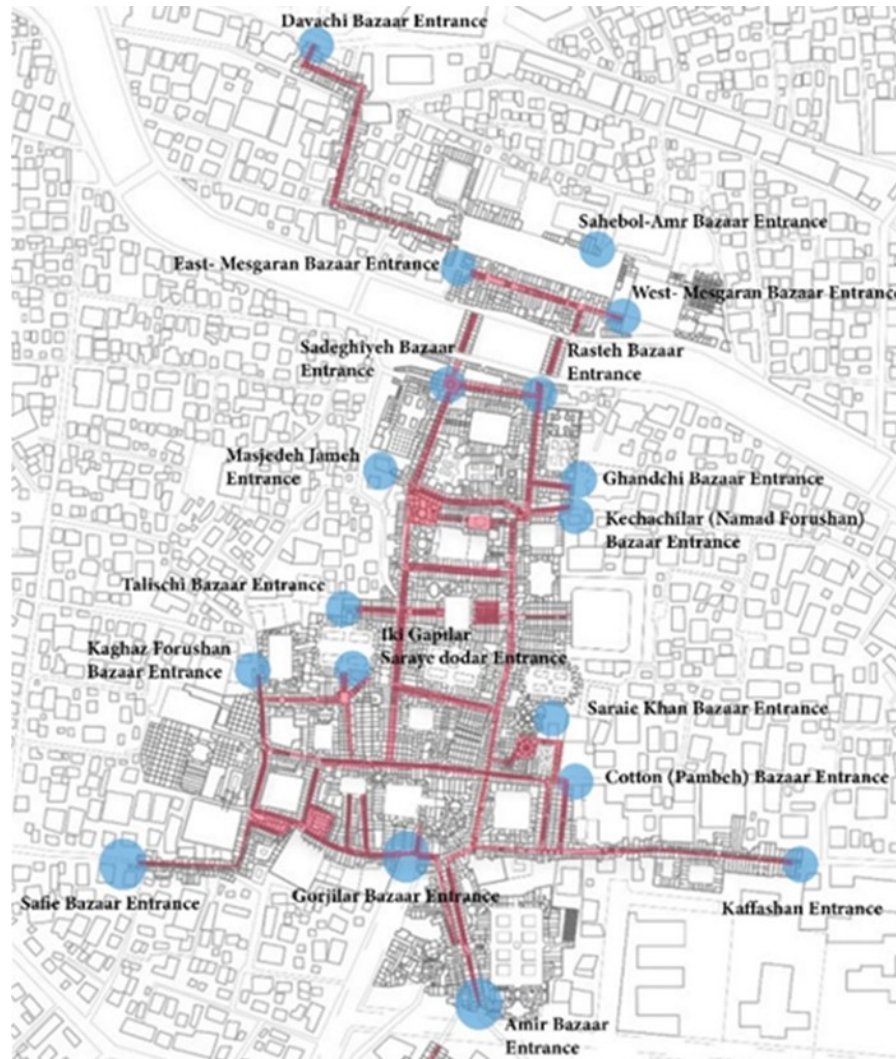


Figure 10. Entrances and access to Tabriz Bazaar, showing the hierarchy of main and secondary routes and their integration with the surrounding urban fabric, (Golkarian, 2021a).

3.4 Functional organization of caravanserais in Tabriz bazaar

From a physical perspective, the introverted spatial organization of caravanserais, which were typically structured around a central courtyard, provided both access and control. Figures 11 and 12). The courtyard served as the main operational core for loading, unloading, temporary storage, and interaction between merchants, while the surrounding rooms and upper floors were used for offices, storage units, and temporary accommodation. This configuration allowed for clear functional separation while maintaining efficient internal circulation. At the same time, controlled entrances connected these spaces directly to the main corridors, establishing a balanced relationship between openness and security (Golkarian, 2021a).



Figure 11. Figures of caravanserais in Tabriz bazaar (Taken by author).



Figure 12. Figures of caravanserais in Tabriz bazaar (Taken by author).

In the economic hierarchy of the bazaar, caravanserais occupied a distinct position. While the linear corridors supported retail activities and high-frequency pedestrian interaction, caravanserais primarily housed wholesale trade, commercial negotiations, and the storage of valuable goods. This distinction demonstrates the direct relationship between spatial accessibility and economic specialization. Spaces with higher public access were associated with retail exchanges, while deeper, more controlled spaces were dedicated to larger-scale commercial operations (Hillier, 1996).

The location of caravanserais in the Tabriz bazaar further reinforces their functional importance. They were typically located adjacent to major circulation routes and near major intersections, allowing them to benefit from high levels of traffic while maintaining semi-private interior environments. This intermediate condition enabled caravanserais to function as intermediary spaces between public corridors and specialized economic activities. Their spatial logic was therefore neither entirely public nor entirely isolated, but strategically situated between integration and control (Hillier, 1996; Yadollahi, 2017).

From the perspective of network theory, caravanserais can be interpreted as semi-nodal elements whose role is defined by their connection to highly integrated routes, rather than by the centrality of an independent configuration. Their proximity to the main corridors of movement increased their capacity to absorb trade flows, while their internal organization allowed for the concentration and consolidation of commercial activities. In this sense, caravanserais transformed movement into economic productivity and supported the clustering of bazaar functions (Batty, 2021; Lefebvre, 1991).

The spatial distribution of caravanserais in the Tabriz bazaar demonstrates a strong relationship between configurational structure and economic concentration. These spaces functioned not only as supporting infrastructures but also as active agents in organizing movement, exchange, and commercial hierarchies within the bazaar network. Their role directly contributed to reinforcing spatial centrality and stabilizing economic activities throughout the bazaar, (Figure 13).

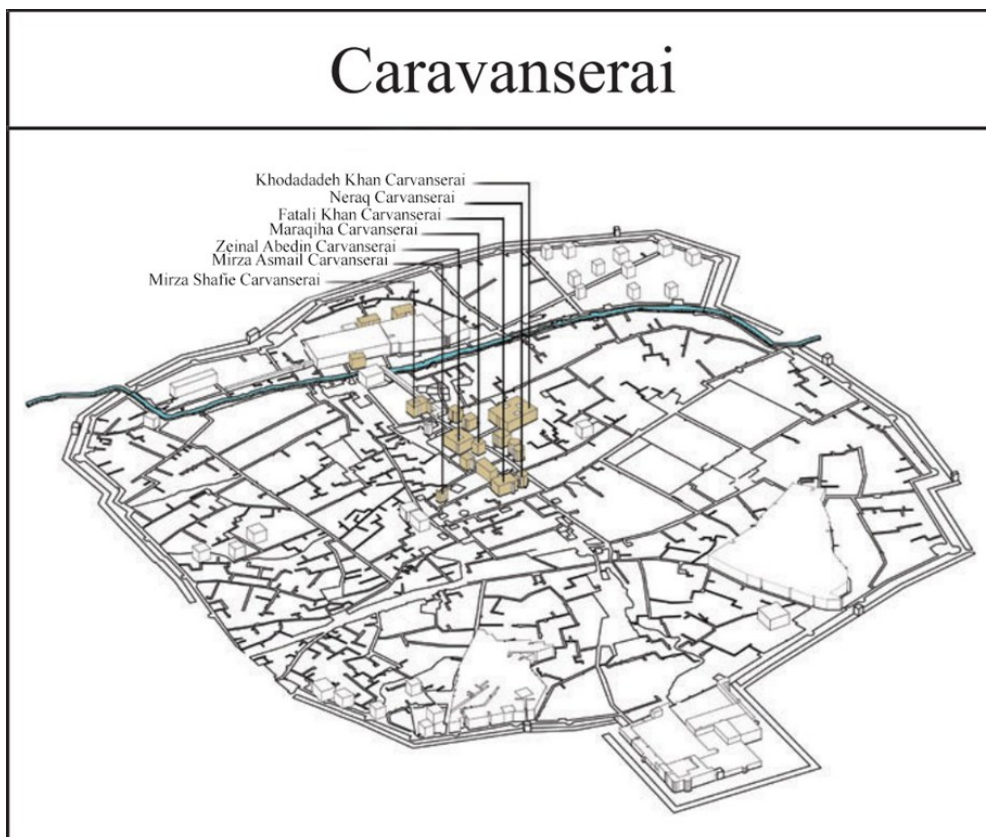


Figure 13. Spatial distribution of caravanserais in Tabriz Bazaar, showing their concentration along the main circulation axes and their connection to the main commercial axis (Shalchi, 2013).

Furthermore, the multifunctional nature of caravanserais enhanced the adaptability of the bazaar system in response to economic developments. Their capacity to adapt to changing trade practices, while maintaining their structural role, helped to maintain the continuity of the bazaar despite urban modernization and changing access patterns. This flexibility explains why caravanserais remained functionally relevant even as urban systems and wider transportation evolved (Madanipour, 2003).

In general, the caravanserais of the Tabriz bazaar should not be understood simply as architectural enclosures, but as spatio-economic interfaces that mediate circulation and exchange, access and control, and local retail and regional trade. Their functional organization demonstrates their role as semi-nodal elements that reinforce the continuity and flexibility of the bazaar system.

4. Results

4.1 Spatial Configuration and Network Analysis of Tabriz Bazaar

Analysis of the spatial configuration of Tabriz Bazaar reveals a highly distinct hierarchical network built around a limited number of highly integrated movement corridors.

The results show that the main axes of the order constitute the most accessible and spatially integrated routes within the system and act as the main commercial backbone of the bazaar. These routes correspond to the areas with the highest pedestrian movement and the strongest commercial concentration, (Figure 14).



Figure 14. Urban street network around the Tabriz Bazaar, showing the contrast between wide automobile-dominated streets and the predominantly pedestrian internal circulation of the bazaar (Developed by author).

As shown in Figure 14, the contemporary urban street network around the bazaar is dominated by wide automobile-oriented roads, contrasting with the finely textured pedestrian circulation within the bazaar. This contrast highlights the spatial and functional discontinuity between the historic bazaar and modern urban development. Caravansaries are generally located in close association with these highly accessible corridors and near important intersections. However, they do not consistently correspond to the absolute peak of spatial integration. This suggests that caravansaries do not function as primary generators of movement. Instead, they function as semi-nodal spatial-economic elements embedded in the hierarchical network of the bazaar. Their location allows them to benefit from high accessibility while maintaining a certain degree of spatial separation from the busiest public routes. This configuration suggests that the role of caravanserais is structurally supportive rather than productive. They reinforce the clustering of commercial, warehousing, and exchange activities in the bazaar, while their connection to the main routes of commodity circulation enables them to participate in the broader spatial economy of the bazaar system.

4.1.1 Global Integration

To understand the overall spatial hierarchy of Tabriz bazaar, global integration analysis was performed using syntactic measures including HH, P-value and TKel, (Figure 15).

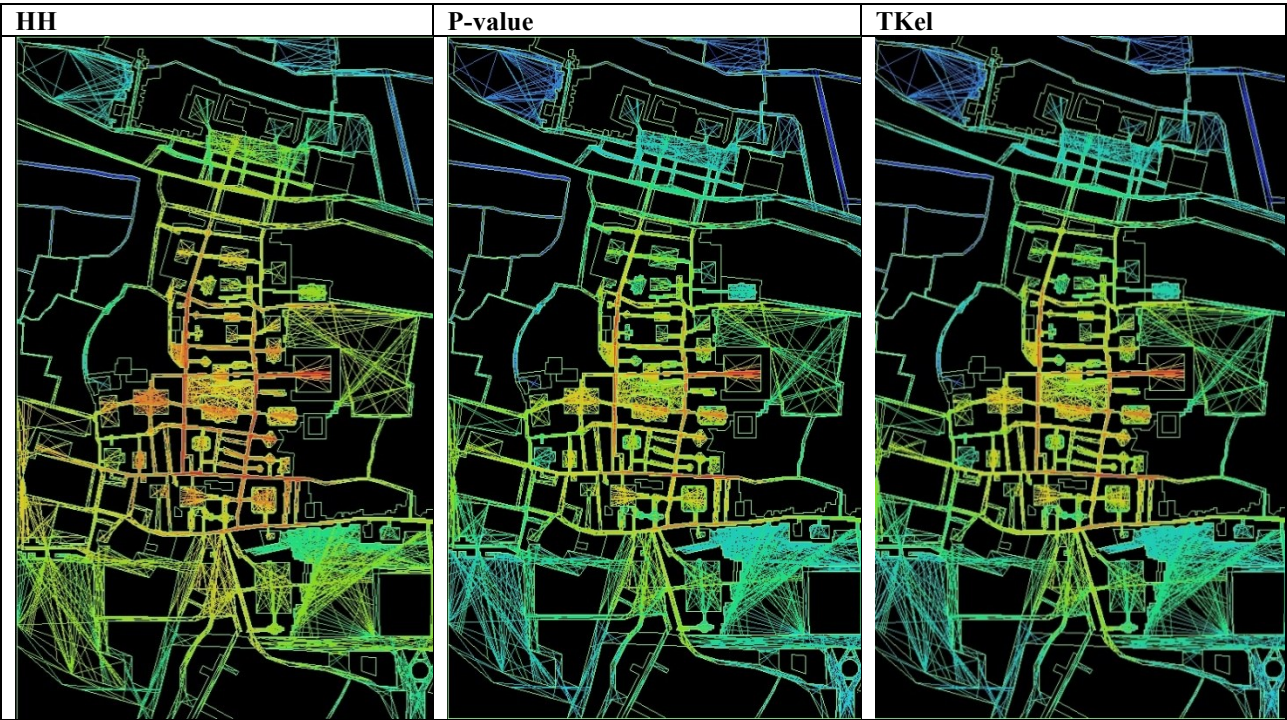


Figure 15. Global integration analysis (HH, P-value, TKel) of Tabriz Bazaar, (Developed by the author).

The results show that the main axes of the order form the most integrated structure in the bazaar. These highly integrated lines correspond to the main movement corridors and areas where the most commercial activity takes place. The central parts of the bazaar show the highest values of integration, while the inner and more peripheral spaces appear relatively separated.

Caravansaries are generally not located at the absolute maximum of integration, but rather close to these integrated routes. This location suggests that caravansaries benefit from strong accessibility while maintaining a degree of internal spatial control. Their location supports their role as semi-nodal spaces that contribute to and reinforce the bazaar’s commercial hierarchy, without fully determining its main movement structure (Hillier, 1996; Batty, 2021).

The integration map also shows that the bazaar is organized around a dominant linear-commercial axis. Caravanserai are mainly distributed along this integrated structure rather than in isolated or peripheral parts of the system. This pattern confirms that their spatial logic is closely related to the main trade routes of the bazaar.

4.1.2 Connectivity Analysis

In addition to global reach, local connectivity analysis was performed to assess the immediate spatial relationships between segments and identify the density of direct links within the network, (Figure 16).



Figure 16. Connectivity analysis of the Tabriz bazaar, (Developed by the author).

Connectivity analysis shows that the central routes of the bazaar have the highest number of direct spatial links. These spaces correspond to the densest intersections and the most active parts of the circulation network. In contrast, spaces located deeper in the bazaar have lower connectivity values and are more dependent on their connections to the main axes. Caravansaries are usually located in areas with moderate rather than maximum connectivity.

This reflects a conscious spatial logic in which caravansaries are located close enough to benefit from movement and access, but far enough from the busiest nodes to maintain a controlled and semi-private interior environment. Such a position is consistent with their historical functions as spaces for storage, negotiation, wholesale trade, and regulated exchange (Kostof, 1991; Madanipour, 1996).

The connectivity results therefore reinforce the interpretation that caravansaries occupy an intermediate position in the bazaar network. They are accessible and well-connected, but not fully exposed to the highest levels of circulation pressure.

4.1.3 Average Depth

A medium depth analysis was conducted to assess the relative accessibility of spaces from the overall system and identify their place in the internal bazaar hierarchy, (Figure 17).



Figure 17. Average depth analysis of the Tabriz Bazaar, (Developed by the author).

This analysis shows that the central axes of the bazaar have lower average depth values, indicating greater accessibility than the system as a whole. The peripheral spaces and internal sub-areas show higher depth values and are therefore more spatially segregated.

Caravanserais are generally located at intermediate depth levels. This finding is significant because it suggests that they are neither fully exposed public spaces nor deeply segregated internal enclosures. Instead, they function as transitional spatial environments located between highly accessible public routes and more controlled internal commercial areas.

This average depth supports the interpretation of caravanserais as semi-private, semi-nodal spaces. Their spatial location allows them to mediate between public circulation and specialized economic activities, reinforcing their role in the bazaar as spaces of controlled exchange rather than fully open public movement.

4.1.4 Line Length and Number of Nodes

To further investigate the structural characteristics of the bazaar network, analyses of line length and number of nodes were conducted, (Figure 18).



Figure 18. Distribution of lane length and number of nodes in Tabriz Bazaar, (Developed by the author).

The lane length analysis highlights the dominance of long linear corridors that constitute the main movement system of the bazaar. These corridors form the underlying skeleton of circulation and provide the main routes through which movement is distributed throughout the network.

The analysis of the number of nodes shows that the greatest concentration of intersections occurs along the central axes. These nodes act as the main points of interaction and spatial convergence in the network. They represent critical moments where the intensity of movement, route choice, and commercial visibility are concentrated.

Caravanserais are often located near these nodes, but not directly at the busiest intersections. This again indicates a spatial strategy based on balance. Their location allows them to benefit from the benefits of accessibility and movement without being reduced to mere passage spaces. This reinforces their role as semi-nodal spatial-economic elements operating at the edge of high-intensity circulation areas, while maintaining a distinct internal commercial logic.

4.1.5 Entropy and Spatial Complexity

Entropy measures were used to examine the degree of spatial differentiation and structural complexity in the bazaar network (Figure 19).

Higher entropy values are concentrated in the central parts of the bazaar, indicating a more distinct and complex spatial structure in these areas. These areas correspond to parts of the network where multiple functions, routes, and forms of movement overlap. Caravanserais are generally located in areas of moderate entropy. This indicates that they are located in spatial conditions that are neither too simplified nor too chaotic. Such a location is functionally advantageous because it allows caravanserais to maintain their internal organization while remaining connected to dynamic areas of exchange and interaction. Thus, entropy analysis confirms that caravanserais are not discrete architectural units. Rather, they are integrated components of a complex and adaptive business system whose functioning depends on spatial differentiation and controlled access.



Figure 19. Entropy and relative entropy analysis of Tabriz bazaar, (Developed by the author).

4.1.6 Spatial Intensity

A spatial intensity analysis was conducted to identify areas of concentrated movement and interaction in the bazaar, (Figure 20).



Figure 20. Spatial intensity analysis of Tabriz bazaar, (Developed by the author).

The intensity map shows that the highest levels of spatial interaction occur along the main axes of the integrated bazaar. These areas correspond to the most active trade corridors and the strongest channels of movement in the bazaar. Caravanserais are usually located at the edges of these high-intensity areas rather than in their core. This spatial relationship is particularly important because it allows caravanserais to accommodate economic flows while maintaining a more controlled internal environment. Their location supports commercial interaction, but also maintains the relative stability required for wholesale trade, storage, and negotiation. This pattern provides strong evidence for interpreting caravanserais as semi-nodal elements, (Figure 21). They are closely linked to the main bazaar movement economy, but their function depends on being somewhat removed from the exposed and busy circulation spaces.

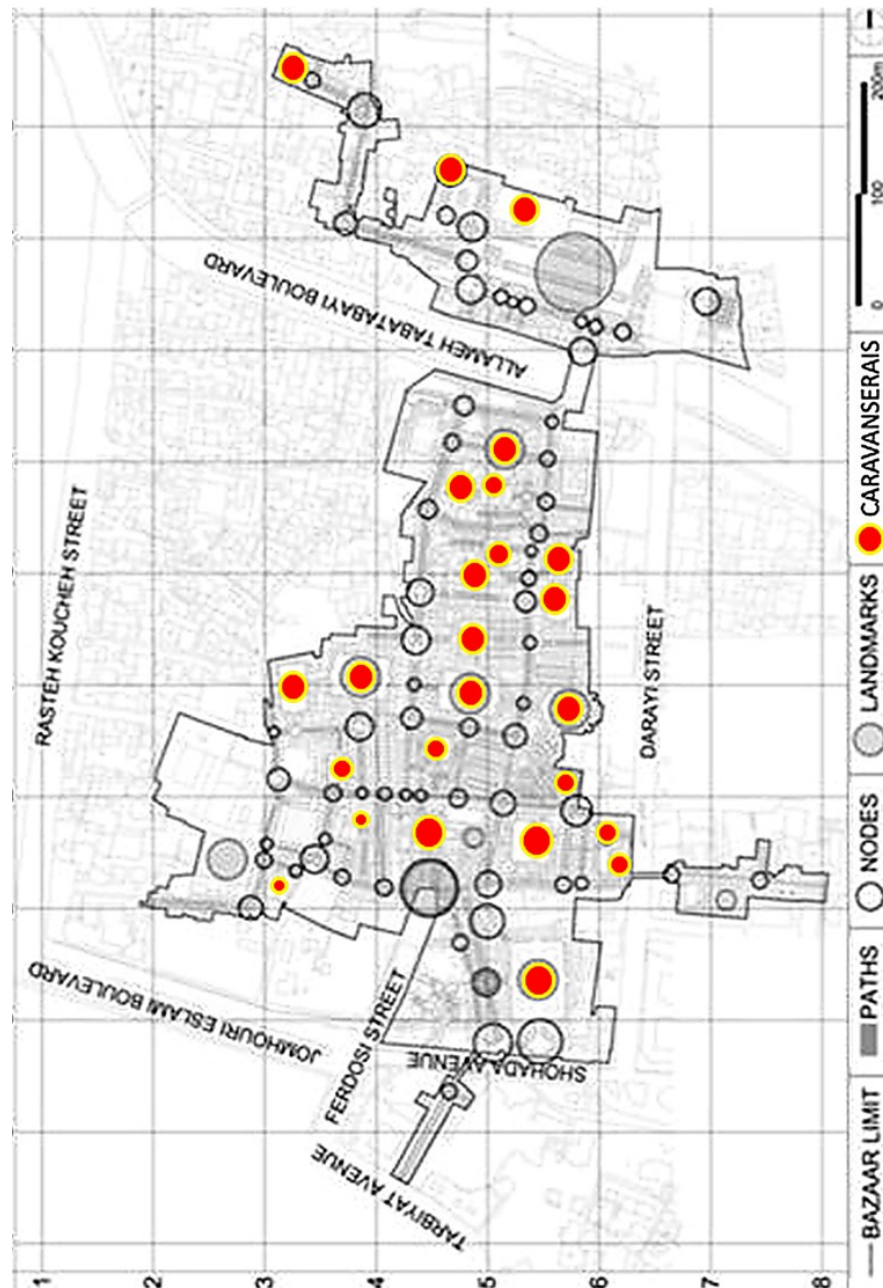


Figure 21. Spatial distribution of caravanserai nodes in the historical bazaar of Tabriz based on empirical mapping, (Developed by the author).

4.1.7 Integrated Spatial Structure and Caravanserai Location

The spatial analysis obtained from Depthmap (spatial syntax) reveals a clear hierarchical structure in the historical bazaar of Tabriz, where movement flows and configuration features are unevenly distributed throughout the network. The integration analysis, visualized through a color gradient from blue (low integration) to red (high integration), shows that the main movement corridors are concentrated along the central longitudinal spine and its key transverse connections. In this structure, the caravanserai, identified as fixed nodes based on empirical mapping, show a distinct spatial pattern. Rather than occupying the axial lines with the highest integration (red areas), most caravanserai nodes are located in areas of medium to high integration (yellow to orange areas), often at the intersection of secondary routes and adjacent to the main corridors. This suggests that caravanserais are not central nodes in terms of pure configurational dominance, but rather act as intermediary spatial elements. This intermediary position suggests a semi-nodal role, where caravanserais act as transitional anchors between highly accessible trade routes and deeper, less integrated spatial domains. Their spatial location allows them to benefit from proximity to high-traffic corridors while maintaining suitable spatial conditions for warehousing, trade, and residence functions. Furthermore, the correlation between node size (which indicates the intensity of network presence) and proximity to integrated routes reinforces the hypothesis that caravanserais are strategically located in the spatial logic of the bazaar. Larger nodes tend to cluster near areas with greater movement potential, reflecting the relationship between spatial accessibility and economic importance. The overall pattern confirms that the Tabriz bazaar is not organized around single dominant nodes, but rather through a distributed network of semi-nodal elements, where caravanserais contribute to both the spatial continuity and economic resilience of the system. They act as connectors, attractors of movement, and stabilizers of commercial activity in the complex urban context (Figure 22).

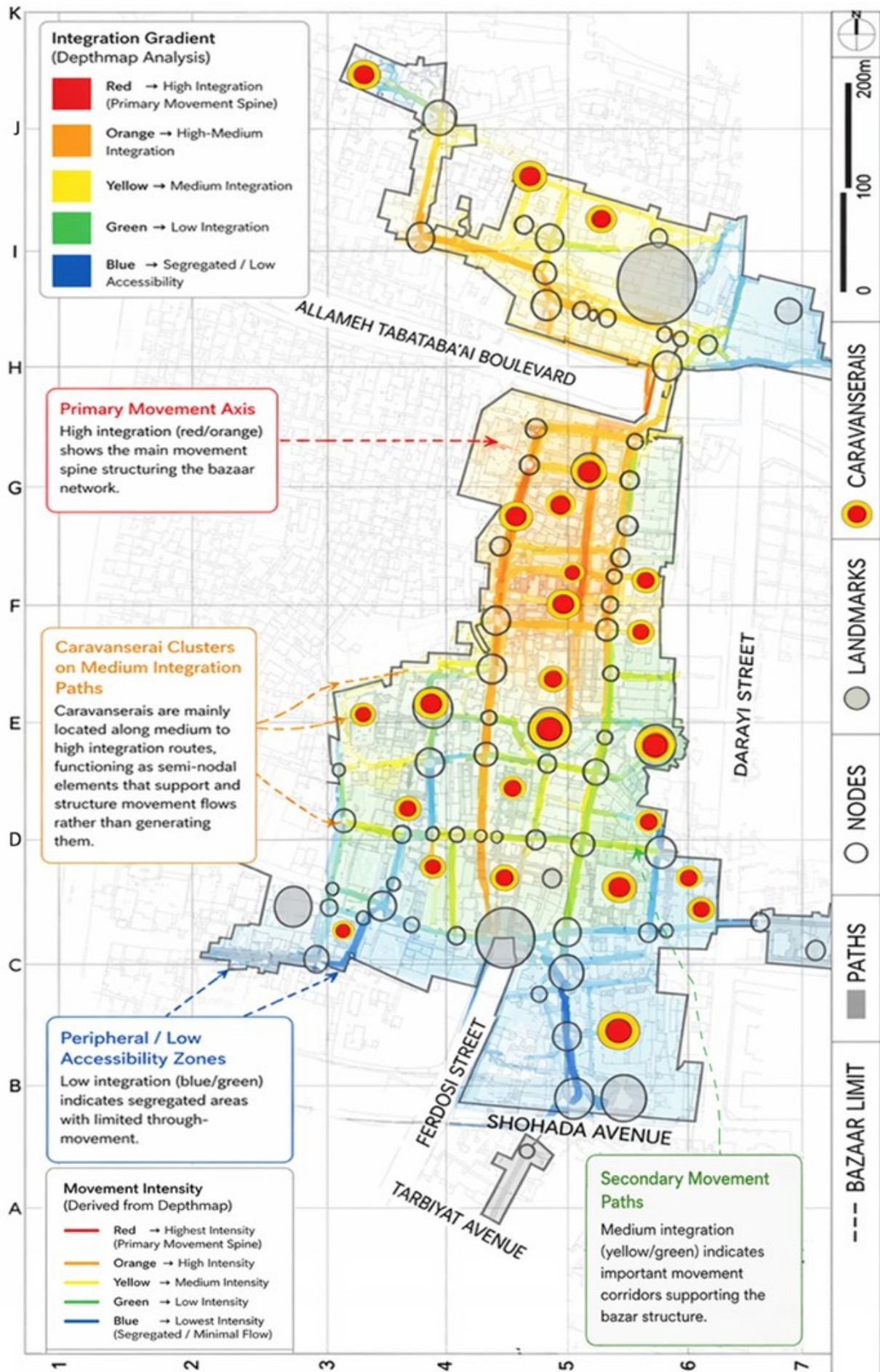


Figure 22. Integrated spatial analysis of Tabriz bazaar based on Depthmap (spatial syntax), showing the hierarchy of movement through the integration gradient (red = up, blue = down), (Developed by the author).

Caravanserais are mapped as empirical nodes located along accessible corridors but outside the peak integration cores, (Table 2), (Table 3), (Table 4).

Table 2. Spatial role of caravanserais based on spatial syntax analysis (Depthmap).

Analytical Index	Observed Pattern	Interpretation	Spatial Role of Caravanserai
Integration (Integration: HH, P-value, TKel)	Highest values in main lines (red); caravanserais in yellow to orange range	Close to strong currents without being at the peak of integration	Adjacent to main paths but not the main generator of movement
Connectivity	Most connectivity at major intersections; caravanserais at intermediate levels	No role in choosing major routes	Connected to the network but not decisive nodes
Mean Depth	Located at a medium depth	Neither fully exposed, nor fully secluded	Intermediate position (semi-public/semi-private)
Intensity	Focusing movement in the central spine; caravanserais at the edges	Not generating movement	Attracting and converting flow into activity
Node Count & Line Length	Highest density on main routes; caravanserais adjacent to them	Dependent on main traffic structure	Existing network reinforcement
Entropy	Being in the medium entropy range	Moderate complexity	Suitable for controlled economic activities

Table 3. Functional interpretation of caravanserais in the bazaar network.

Urban function	The role of caravanserais	Urban function	The role of caravanserais
Generating movement		No	
Guide the main structure		No	
Strengthening the spatial structure		Yes	
Creating an economic cluster		Yes	
Attracting movement		Yes	
Mediating between movement and activity		Yes	

Table 4. Conceptual position of caravanserais in the spatial structure.

Classification	Definition	Caravanserai location definition classification
Primary Node	Generating movement and having the highest integration	✗
Passive Space	Low interaction and isolated	✗
Semi-nodal Element	Having relational importance in the network	☑

5. Discussion

The findings suggest that the Tabriz bazaar operates as a structured, network-based system in which movement and access are concentrated along a limited number of highly integrated spatial corridors. These corridors form the dominant spatial backbone of the bazaar and act as the main generators of movement and trade intensity. Within this hierarchical structure, caravanserais occupy a distinct intermediate position. Although they are consistently located in the vicinity of highly integrated routes, they do not correspond to the strongest syntactic cores or the highest levels of configural centrality. This suggests that caravanserais do not function as main generators of movement, but rather as spatio-economic elements embedded in and dependent on the broader network structure. To interpret this situation, the concept of semi-nodalism is proposed. Unlike conventional nodes, which are defined by configural centrality, semi-nodal elements derive their

importance from their relational position in the network. Their role emerges through interaction with movement flows, economic activities, and functional dependencies rather than simply through geometric centrality. In this framework, caravanserais can be considered as hybrid spatial entities that mediate movement and activity. Their entrances have direct connections to highly integrated routes and ensure access, while their inward-facing courtyard structures provide semi-controlled environments for storage, negotiation, and exchange. This dual status allows caravanserais to simultaneously support access and functional specialization. As a result, caravanserais do not independently generate movement, but rather amplify, absorb, and stabilize existing flows. Their location at the edges of high-intensity movement areas enables them to transform circulation into local economic activity and contribute to the clustering and stabilization of commercial practices in the bazaarplace. This interpretation challenges the conventional binary distinction between routes and nodes in spatial analysis. The findings suggest the existence of intermediary spatial elements whose importance lies in relational positioning rather than absolute centrality. Caravansaries are an example of such elements that act as interfaces between highly integrated circulation systems and more controlled internal economic spaces. From a network perspective, they act as economic attractors that support the clustering of commercial activities. Morphologically, they reinforce the spatial hierarchy of the bazaar (Kostof, 1991), while from a socio-spatial perspective, they facilitate interaction in semi-controlled environments (Lefebvre, 1991). These overlapping roles highlight their integrated function within the system. Furthermore, the persistence of this spatial logic demonstrates the structural resilience of the Tabriz bazaar. Despite modern urban developments, the alignment between spatial configuration and economic practices has enabled the system to maintain its functional coherence. In contrast, contemporary commercial environments often operate as isolated, introverted systems, lacking such spatial continuity (Relph, 1976). In general, caravanserais should not be understood as dominant nodes, but rather as semi-nodal spatial-economic elements that mediate movement and activity, access and control, thereby contributing to the stability, continuity and adaptability of the bazaar network.

6. Conclusions

This study examined the spatial role of caravanserais in the Tabriz bazaar through a network-based analytical framework supported by spatial arrangement methods. By integrating configuration analysis with functional interpretation, this research provided a systematic understanding of how caravanserais functioned within the hierarchical structure of the bazaar. Findings show that caravanserais are consistently located in the vicinity of highly integrated routes and active commercial corridors, but do not coincide with the strongest syntactic nodes. This spatial situation suggests that caravanserais do not act as primary generators of movement. Instead, they function as semi-nodal spatio-economic elements that support, structure, and stabilize existing movement patterns and commercial hierarchies in the bazaar network. The semi-nodal concept introduced in this study provides a revised interpretation of spatial hierarchies in complex urban systems. This concept challenges conventional binary distinctions between nodes and routes by suggesting that some urban elements derive their significance from relational positioning rather than merely from configurational centrality. In this context, caravanserais emerge as hybrid spaces that mediate movement and activity, access and control, and public and semi-private domains. From a methodological perspective, this study demonstrates the potential of combining quantitative spatial analysis with qualitative functional interpretation to better understand traditional urban systems. Integrating measures such as integration, connectivity, spatial depth, and intensity allows for a more nuanced reading of the relationship between spatial configuration and economic activity. From an urban and heritage perspective, the findings emphasize the importance of preserving not only the physical fabric of historic bazaars, but also their underlying spatial logic. The effectiveness of the Tabriz bazaar as a commercial system is rooted in the alignment between movement structures and economic functions, in which elements such as caravanserais play an important mediating role. More broadly, this study contributes to ongoing debates about place and placelessness by demonstrating that traditional bazaars represent highly integrated, place-based spatial systems. In contrast, many contemporary commercial environments tend to operate as introverted, fragmented structures with weaker relationships to the surrounding urban context (Relph, 1976). Understanding caravanserais in this framework provides a basis for developing more effective strategies for integrating historic commercial environments into contemporary urban contexts. This suggests that future interventions should focus not only on conservation, but also on maintaining and enhancing the spatial relationships that sustain the functional and social coherence of such systems.

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Conflicts of Interest

The author(s) report no conflicts of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Spatial data used in this research were derived from historical maps, field observations, and publicly available documentation from the UNESCO World Heritage nomination dossier of the Tabriz Historical Bazaar Complex and the Iranian Cultural Heritage, Handicrafts and Tourism Organization (ICHHTO).

Institutional Review Board Statement

This section is not available, not applicable. This study does not involve human participants, animals, or experiments that require ethical approval.

CRedit Author Statement

Conceptualization, Methodology, Software, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Validation, Funding acquisition, all are developed by Shabnam Golkarian

The author has read and approved the final manuscript.

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