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Original Research Article

The Impact of Shifting Trade Routes During the Safavid Period on the Transformation of Caravanserais in Central and Southern Iran*

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Abstract

Problem statement: Caravanserais of the Safavid period underwent significant changes in their typology and architectural structure from the beginning to the end of the dynasty. These typological shifts were likely influenced by a variety of factors, and identifying and examining these influential factors is of paramount importance.

Research objective: The aim of this research is to examine the changes in various architectural elements of caravanserais during the Safavid era, focusing on how shifts in distance and trade volume along routes leading from land to sea affected this architectural type. The research question posed here is: how did changes in trade routes during the Safavid period impact the typology and structure of caravanserais of this era?

Research method: This research, grounded in the theory of evolutionary typology, adopts a descriptive-analytical approach and utilizes both quantitative and qualitative data. It investigates the impact of shifting trade routes on the physical characteristics of 15 major caravanserais built along these routes during the Safavid period. These caravanserais were purposefully selected to allow the examination of various relevant variables.

Conclusion: The research found that the shift from land to sea trade routes changed the design of caravanserais. Caravanserais along the Silk Road were built for large caravans and long stays, while those along maritime routes were smaller and designed for shorter stays and more goods.

Keywords: *Trade Routes, Safavid Period, Caravanserais, physical Structure.*

Introduction

Various types of caravanserais are found in Iran's architecture (Rahro Mehrabani & Nouri, 2022), and the location and construction procedure of caravanserais' architecture are the major factors in classifying the types of this construction (Tabassi & Naseri Azghandi, 2020). Spatial location includes intraurban and interurban caravanserais (Vahdatpour et al., 2019), and the construction style of architecture includes

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caravanserais with a yard, with a castle, or mountainous ones (Basouli & Derakhsh, 2021). Therefore, the typology of caravanserais should be examined in this framework.

Examination of spatial location for the typology study of caravanserais concomitantly leads to the examination of temporal situation (Saeedinia, 2010).In the Safavid and Ghajarid periods, traders were attracted toward commercial journeys from the seaside such that the main route of trade with India and eastern Eurasia was from the open waters of southern Iran, a situation affecting the formation of caravanserais with rapid appearance and easy construction (Hillenbrand, 2015). The unique features in the structures of in-transit caravanserais always result from responding to needs and different factors (Pourmohamed, 2013). On the other hand, the need for rapid construction and, on the other side, the need to provide comfort situations in different regions and shelter against air draft and shadow led to changes in the physical structures of caravanserais (Ghobadian, 2006; Pourmohamed, 2013). A prominent example of such a change is the structures of caravanserais in hot and dry areas, mainly located close to the open waters of southern Iran. The presence of stones in the construction materials of caravanserais in the warm and wet climate of southern Iran accelerated the construction, and the lack of a small-scale central yard in the main form of structures provided the development of rapid commercial transportation. Although the construction of caravanserais was not common in the Ghajarid period relative to the Safavid era, the construction of these new structures continued as the criterion language, growth pattern, and commercial prosperity, and in the construction of caravanserais in the Ghajarid era was largely inspired by the Safavid period.

The current study scrutinizes the reasons for the emergence of these paths as new commercial routes and the emergence procedure of new infrastructures. This is because the provision of dynamicity in the routes of commercial trips is dependent on the location and structures of constructions enabling this dynamicity and, on the other hand, their structure is affected by environmental nature and needs. The ultimate goal of this structure as a whole is nothing but to select the best and easiest path for trade. Therefore, the current study seeks to establish a relationship between caravan paths and commercial models in the Safavid period. In other words, the aim is to establish a relationship between political, social, and economical changes on the one side and the physical environments of caravanserais as a reflection of these changes mediating the emergence of social behavior on the other side. This research also aims to evaluate the effect of changes in commercial models on the construction of caravanserais. Hence, the location of commercial paths is studied relying on achieving the best and most facilitated path, followed by elaborating on the relationship between infrastructure needs and the structures of caravanserai as infrastructure for providing path dynamicity based on evolutionary typology. This goal analyzes the formation of the physical structures of in-transit caravanserais, spatial structures, and the corresponding geometric form. This research also tries to illustrate a part of Iranian architecture history and simultaneously elaborate on factors affecting the changes in the typology of the caravanserais architecture in the Safavid period using a descriptive-analytical method based on quantitative and qualitative data.

Theoretical Foundations

Typology (Hayati et al., 2020) mainly aims to classify samples based on functional, physical, social, and environmental features (Mirsajadi & Farkish, 2016) for the deeper discovery and identification of the study platform (Sadberenji, 2017) and extraction of components affecting the subject's nature (Omidvari & Basouli, 2021). In addition to discovering components' relationships (Shahteimouri et al., 2011), this method addresses the problems from a multidimensional historical-geographical viewpoint (Noghrehkar et al., 2018).

Architectural typology represents foundations, components, theoretical fundamental, and basic patterns (Mohamadianmansoor & Faramarzi, 2011) and the importance of a type during continual phenomena

related to its evolution (Mashhadi & Aminpour, 2017). The new meaning obtained from type concepts indicates the presence of various contradictions in the definition of nature and genre of a case sample (Mirsajadi & Farkish, 2016), enabling its new social and evolutionary interpretation (Mashhadi & Aminpour, 2017). From an architectural evolutionary typology viewpoint, logical interactions of social, economical, and political platforms are regarded as the parameters affecting the main form of architecture and show that a pattern preserves the fundamentals and evolves despite the political, economical, and social effects (Memarian & Dehghani Tafti, 2018).

A combination of the research pattern with the study procedure of the physical structure and social, economical, and cultural factors allows for the correct classification and organization of the basic evolution procedure. Therefore, the study of the typology course should review all visual and intrinsic contradictions. Therefore, the current study examines the relationships between different components of an architectural type, their changes over time, and their relationships with social and historical activities of commercial trips during the Safavid period. This study deems the relationships and locations of physical components to be a reflection of necessary environmental and geographical needs for developing the commercial path dynamicity (Fig.1).

Political and Economical Research Background

The importance of the trading path has always been the focus of various studies. Tagavifar et al. (2018) investigated the trading relations of the Safavid government with Ottomans from the Safavid king period up to the Safavid fall. They denote the try of Safavid and Ottoman governments to apply their trading benefits as a bargaining chip and believe that the engagement of Western people to the Persian Gulf and eastern Mediterranean equations resulted in a decrease in the political determination of Safavid and Ottomans in the area. Rahmati et al. (2020) demonstrate war with Ottomans, Uzbeks, and Portuguese as the main factor of the importance of the north-south commercial path and gathering of traders in cities of this commercial line in a study on the effect of border wars of the first Safavid Shah Abbas on the dispersion of traders in Iran. In a study on the Russian-Safavid relations and Russian diplomacy in 1715-1735, Gozalova (2024) examines the Russian government's goals in establishing political and trading relations with neighboring countries, including Iran, and shows that trading between Russia and the Safavid government could change land and marine commercial equations. Ehsani et al. (2021) believe that the gradual establishment of security all along the Safavid territory was a result of the innate changes in the economical system in the Safavid first Shah Abbas and its effect on commercial activities (by relying on votes of Douglass North)" in the fields of politics and societies, resulting in the security of roads, construction of caravanserais, among others. In their study on the economical and political position of the Persian Gulf during the Safavid period, Karshenasan & Shahin (2013) focus on the importance of the Persian Gulf through the review of the position, occurrences, and different historical periods in the study and policy-making about economical and political problems of

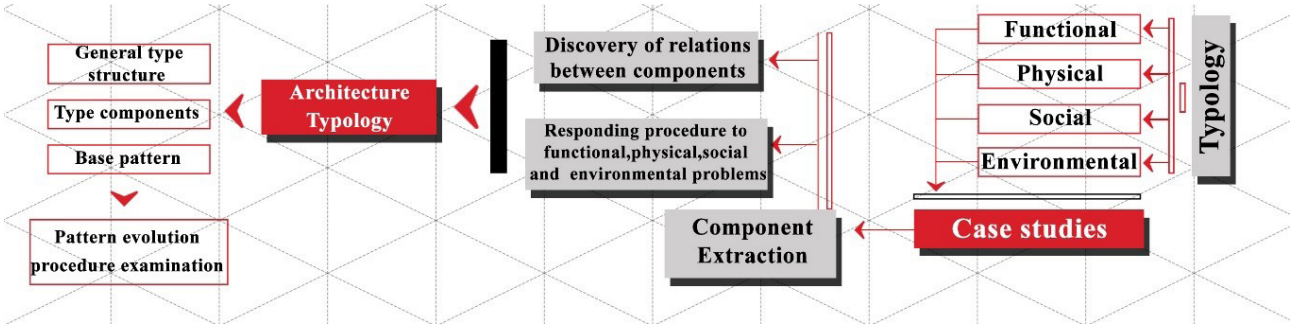

Fig. 1. The research theoretical framework. Source: Authors.

this important sea. For this purpose, they investigated its specific geopolitical and geoeconomic position concerning rich natural resources and commercial four-way location and then underlined the importance of the Persian Gulf regarding the commercial prosperity of Hormoz traders in the Safavid era as the main road of east and south trading and commodity bargaining after the blockage of the commercial land Silk Road by the Ottomans government. Changes in land commercial roads to marine ones were a factor involved in forming related construction structures. Talebian (2016) examines the cultural routes based on natural corridors concerning related elements, signs, and different occurrences in the research on the perspective of the road in Iran. The mentioned research studies various types of cultural roads in historical periods. Hasibi et al. (2024) elaborate on mathematical patterns and models for the architectural types of the caravanserais in the Safavid era, in an article on the demonstration of a historical dynamic analysis model of commercial journeys by focusing on caravanserais in the Safavid period. They attribute the increasing flexibility of these spaces to commercial factors, such as commercial potentials, trip risk, and difficulties in the passageways of caravans, formed through various changes. The physical factors change to line with the mentioned factors, and caravanserais are evaluated according to their location in different climates and commercial roads. In the end, the scientific framework for the prediction of commercial roads is demonstrated by relying on caravanserais' physical properties.

Kavian & Gholami (2016) examined the evolution course of yard-possessing caravanserais in central Iran and addressed ambiguities around changes in the structural and spatial changes of caravanserais in different periods. Their descriptive-analytical article based on library studies reviews the constructions of caravanserais from the pre-Islam era. In the end, they reviewed different models in various historical periods and mentioned Ghajarid caravanserais as the complement and continuation of caravanserai construction patterns in the Safavid period.

By examining caravanserais and main policies in the Safavid and Ghajarid periods, Fazeli (2011) concluded that the Silk Road was a linker of the main body of old civilizations in three Eurasia nations, in research on the Silk Road and Iran's role as a factor of connection between south and east in the ancient period. These three civilizations included China, Toran India, Central Asia, Mesopotamia, Iran, and Yemen in Asia, European civilizations (including Greece and Rome and other side civilizations in southern Europe), African civilizations (including Egypt, Kosh, etc.), and the Silk Road (all land and marine roads), linking all civilization fields in the southern Pacific Ocean and the eastern Atlas Ocean. The mentioned research summarizes the destruction factors of the Silk Road in multiple factors, including the expansion of marine transportation that was more cost-effective and the progress and facilitation of the communication industry and technology, especially the railroad industry, which covered extensive networks from the most northern point of Russia up to China.

The literature review reveals the lack of a study regarding the typology of Safavid caravanserais, affected by a change in the commercial model and its effect on the structure of caravanserais. Table 1 summarizes the studies in this field based on two political and economical grounds.

Research Method

According to the literature review of the political and economical viewpoints, the turning point of the structures of caravanserais in central and southern Iran in the Safavid period was based on the passage volume of caravans and trading courses with different spaces of caravanserais. Therefore, 15 caravanserais in Isfahan, Kerman, and Hormozgan provinces were selected in the current study based on different general properties of caravanserais, various caravanserais' structures, varying geometries, and spatial complicities. Then, the type and form of plan, general properties including structural connection with caravan path, outer form, spatial composition, construction materials, caravanserais' structure based on entrance and main

Table 1. Background research. Source: Authors.

Authors	Title	Publication year	Political subject	Economical subject
Taghavifar, et al.	Trading relations of the Safavid government with Ottomans from the Safavid King period up to the fall of Safavid	2018	+	-
Rahmati,et al.	The effect of border wars of the Safavid first Shah Abbas on the dispersion of traders in Iran	2020	+	-
Ehsani, et al.	Innate changes in the economic system of Iran in the Safavid first Shah Abbas period and their effects on trading activities (by relying on votes of Douglass North)	2021	+	+
Gozalova	The Russian-Safavid relations and Russian diplomacy in 1735-1715	2024	+	-
Karshenasan & Shahin	The economic and political position of the Persian Gulf in the Safavid era	2013	+	+
Talebian	The road perspective in Iran	2016	-	+
Hasibi, et al.	Elaboration on the historical-dynamic analysis model of commercial trips by focusing on caravanserais in the Safavid period	2024	-	+
Kavian & Gholami	Examining the evolution course of the architecture of yard-possessing caravanserais in central Iran	2016	-	+
Fazeli	The Silk Road and Iran's role as a linker between West and East in the ancient period	2011	-	+

form, connectivity and spatial co-connection in internal spaces, and climate properties were analyzed in each caravanserai. After the analysis, caravanserais' typologies were evaluated separately in central and southern Iran. The agreement between different analyses facilitates the research path for concluding the theoretical course by evaluating the typology of caravanserais. As such, the different highlighted signs in caravanserais located in the passageways of land and marine caravanserais indicate the trading model's prosperity in those caravanserais (Fig. 2).

Case Studies

During the Safavid ruling period, two trading roads, the Silk Road and the Spice Route were the major trading venues through which trading caravans passed and exploited the tools, constructions, and other installments in these paths. Rulers in this period paid high attention to the development of trading paths, and trading prosperity demanded safety provision, route network development, and expansion of urbanization. Trading prosperity was affected by innate changes made by Safavid rulers to reinforce the central government, establish a novel social order, and enhance the socioeconomic structure (Ehsani et al., 2021). These policies expanded marine trading at the end of the Safavid period, and the change in trading paths toward sea caused an increase in trading in cities neighboring open waters. Commercial paths of the Safavid period underwent different changes due to their location in the changes in the Silk Road trading, development of global marine trading, war with Ottomans, Uzbeks, and Portuguese, and the emergence of political and trading relations with the Russian government (Ahmadi & Sadeghi, 2013). The dispute over Safavid government between Iran's neighbors in north-western and eastern borders was due to the conquests of the Safavid government in central, north-western, eastern, and southern Iran. Despite the dominance of this government on roads and trading centers, trading activity and relations with the Asia and Euriope changed during the long period of these wars (Tagavifar et al., 2018). On the other side, trading paths were affected by these wars make the dispersion of traders, making them gather in cities located on safe paths (Rahmati et al., 2020). Due to this policy change and development of marine transportation, previous trading paths of caravans are directed toward

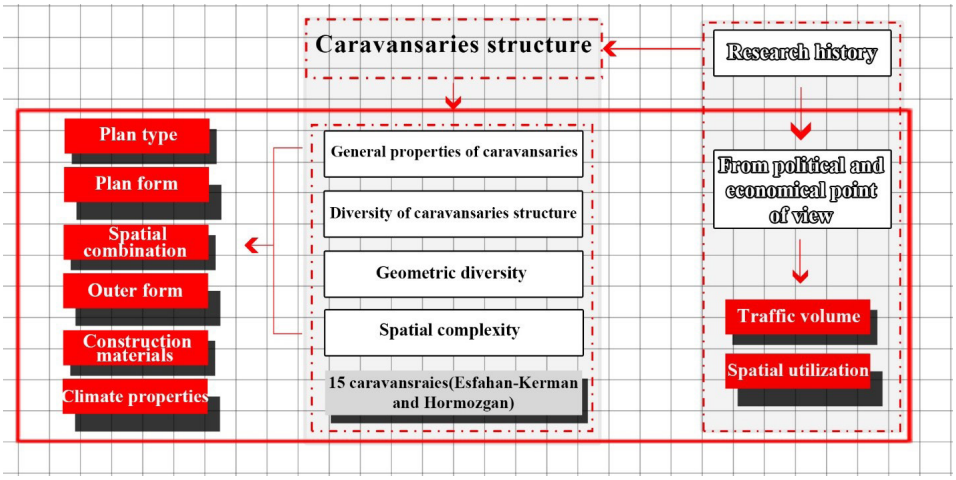

Fig. 2. Research method. Source: Authors.

paths leading to Kerman and from there toward Lar city and Iran's southern ports, including Bandar-Abbas (Sahab, 2004). Open waters of southern Iran in this era were not only the center of collection and export of local commodities of the area or the location of importing required regional commodities and merchandise but also the main center of global east and west trading. In that period, the Persian Gulf and open waters in southern Iran were known as the East and West trading main road for exchanging commodities and China, India, and Far East with Europa with the development of marine transportation by Europeans (Karshenasan & Shahin, 2013). Based on previous findings, the path of trading in the Safavid period was from the current Pakistan toward Esfahan and then to southern, north-eastern, and north-western Iran. Therefore, the selection of case caravanserais was in agreement with the Safavid construction period, political and social occurrences, and provinces related to the trading period of the Silk Road in the Safavid period, which is of great importance in this regard (Hasibi et al., 2024). Esfahan province was in the way of land ground and marine trading routes, and Kerman and Hormozgan provinces were in the marine trading route of the Silk Road and were safe from different wards with Ottoman and Uzbek governments (ibid.). Before the blockage of the Silk Road by the Ottoman government, the passage path from Khorasan toward Tehran and Azerbaijan was the most prosperous and main trading road. By blocking the Ottoman path, trading in this path was replaced by the southern paths of the country (Ranjbar et al., 2012). In southern Iran, Hormozgan province is connected to open waters and has important trading ports such as Bandar Abbas and Hormoz ports, thereby significantly contributing to the marine trading of the Silk Road. This province's vicinity to Kerman province mediated trading prosperity in this province, and the trading paths of Kerman province benefited from the revenue of trading caravans. During the rule of the Safavid dynasty, Esfahan (located in the central plateau of Iran) was the trading and political capital linking southern and northern Iran and was always of interest to traders. Therefore, samples and available documents in Esfahan province are necessary solutions in relevant examinations of the trading routes of caravans.

This research focuses on all in-transit caravanserais in Esfahan, Kerman, and Hormozgan provinces, which were constructed in the Safavid period in line with land and marine trading of the Silk Road. The selection criteria for caravanserais were a documented plan design (including plans and view), spatial structure, spatial combination, and spatial understanding. Accordingly, six caravanserais in Kerman and Hormozgan and twelve caravanserais in Esfahan possessed the mentioned features. Five caravanserais were selected for statistical community selection based on the spatial random sampling method in each province. At first, the locations of caravanserais were determined on the map. Then, a specific number was

assigned to each. Ultimately, five locations in each province were selected for this study using a random number table (Fig. 3).

Caravanserais of southern Iran are divided into two types of caravanserais, the Persian Gulf shore (warm and wet) and warm and dry caravanserais of Iran's central plateau. The presence of a central yard with surrounding camarilla, an outer layer of stables, and brick materials are some features of caravanserais in the central plateau of Iran (warm and dry), which is mostly affected by climate in form plan, structure, and materials. The main form of these constructions possesses a central yard and four terraces with high and dome-shaped roofs. The features of caravanserais in southern Iran (warm and wet) include a four-corner construction with cruciform rooms for external pounds and camarilla. Stone is the main material used in these structures. The form of these caravanserais lacks a central yard and possesses extroverted camarillas with high flat roofs. In this research, caravanserais in Hormozgan province are considered in the warm and wet regions, and those in Kerman and Isfahan provinces are deemed in the dry and warm areas.

Caravanserais are highly diverse in Hormozgan province; however, five caravanserais of Badani 1, Badani 2, Badani 3, Berkeh Sefid, and Berkeh Soltan were selected for the case study due to research objectives. In Kerman province, Baghin, Beiaz, Khanehsorck, Sangto, and Kabotarkhan were the selected caravanserais. The five caravanserais chosen for examination in Esfahan province were Chahghade 1, Hoseinieh, Reviad Bostan, Toor, and Madarshah. In Table 2, the plans of case caravanserais separated by province and names are presented from the book Caravanserais in Iran (Kiani & Kelais, 1994).

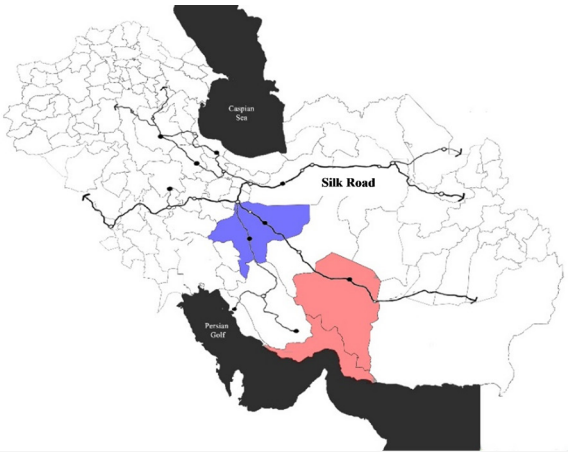

Fig. 3. The location map of case samples in the Silk Road trading path during the Safavid historical period. Source: Sahab, 2004; Ministry of Housing and Urban Development, 2009

Structures of Case Caravanserais

• Plan

Caravanserai is a space for a temporary resting place, both in physical and conceptual aspects. Due to the importance of in-transit trading, special desirability is considered in the plan hierarchy of caravanserais. The hierarchy plays a connective role in basic concepts and can be used as a rich principle in communicating spaces in caravanserais. Due to their application, Iranian caravanserais should necessarily have a united connective plan, and different spaces in caravanserais were accessed by meeting hierarchy, and in the case of extroverted designs, common traits were met according to the hierarchy. Table 2 presents the images of plans for case caravanserais in each province, showing the diversity of studied plans. This diversity is affected by the climate of spatial hierarchy in addition to being influenced by climate; simplicity and complicity of plan spaces are obvious for each location. Introversion is the cornerstone of Iranian traditional architecture, playing a significant role in the physical elements of Iranian traditional structures. Although the climate factor effectively selects introversion in the plans of traditional structures, spatial connections are among the main criteria of the introversion design. Table 2 lists the plan types of caravanserais (extroverted or introverted) in each province. According to this table, more extroverted plans are observed by moving toward the marine paths of the Silk Road.

• General characteristics

General features of caravanserais include structural connection with caravan paths, structural connection with in-transit and urban elements, external form, spatial composition, entrance, year of construction, plan form and type, materials, and other characteristics, which should be examined for more study of in-transit caravanserais' structures.

Table 2. The plans and analyses of case caravanserais separated by the province. Source: Kiani & Kelais, 1994

Titles	Hormozgan					Kerman					Esfahan				
Name	Badani 1	Badani 2	Badani 3	Berkeh Sefid	Berkeh Soltan	Baghin	Biaz	Khaneh Sorkh	Sangto	Kabutarkhan	Chah Qadeh 1	Hoseinijeh	Rivad Bostan	Toor	Madar shah
Age	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid	Safavid
Plan form	Square	Rectangle	Square	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle
Plan type	Extroverted	Extroverted	Extroverted	Extroverted	Extroverted	Introverted	Introverted	Introverted	Introverted	Introverted	Introverted	Introverted	Introverted	Introverted	Introverted
Material	Stone	Stone	Stone	Stone	Stone	Brick	Brick	Stone & brick	Stone & brick	Brick	Brick	Stone & brick	Stone & brick	Brick	Stone & brick
Climate	hot & humid	hot & humid	hot & humid	hot & humid	hot & humid	Hot & dry	Hot & dry	Hot & dry	Hot & dry	Hot & dry	Hot & dry	Hot & dry	Hot & dry	Hot & dry	Hot & dry
Plan															
Structure															
Integration															
Spatial perception	1	1	1	1	1	0.3	0.14	0.85	0.7	0.2	0.38	0.33	0.35	0.34	0.1
Spatial structure															

Different factors were involved in the formation and organization of Iranian caravanserais, the most important of which was climate. Caravanserais have various specific elements based on the plan, volume, and view according to their location in climates or different periods, separating the types (Pourmohamed, 2013). In the construction of Iranian caravanserais, geographical location has an important role in the formation of architectural proportions of these structures such that the height, length, and width of rooms are low in cold and mountainous areas. In particular, the height of stables is extremely low in most cases to use lower fuel needed to provide heat. However, the height-to-length and width ratios of rooms are high in the central plateau of Iran in comparison to mountainous areas. These variations in proportions are due to regional climate differences in Iran (Shahamipour & Farokhi, 2014; Balali Osquoei & Rahimi, 2023). Esfahan and Kerman provinces are located in the hot and dry climate of Iran, and Hormozgan province is located on the warm and wet southern coasts. According to the climatic diversity in the case samples, each caravanserai's architectural proportions are expected to differ in height, length, and width. Table 2 summarizes the features of case caravanserais based on the analysis of the construction structure. The study of this table is an important step in examining the general characteristics of caravanserais. In this table, the structure of caravanserais is considered based on the entrance and main form, and this examination is in line with the analysis of the geometric structure of case caravanserais.

A crucial component of the caravanserais' structure is the type of passage and enjoyment of spaces. The connection between the entrance and main form can be so important in the study of the caravanserais' structures that spatial classification and diversification are based on this component. In Hormozgan province, there are multiple entries to extroverted caravanserais, and all these entrances form a methodological structure in the cruciform plan. On the other side, only vertex spaces of the caravanserai have access to each other, and other surrounding spaces are connected to each other out of the caravanserai's environment. In Kerman caravanserais, a coherent but simple structure with a checkered form governs entrance spaces and the main body, and this structure indicates the relative complicity of spaces in relation to each other. The main entrance to caravanserais in Esfahan was from one path, and a simple coherent structure with a surrounding path is dominant in relation to the main yard. This spatial focus indicates high complicity encompassing internal spaces.

- **Geometry and complexity**

Geometry is the science used for discovering relationships between phenomena and ordering

the environment and surrounding space. The design of various architectural spaces falls under the applications in which geometric feedback is visible significantly. The geometric process identification of an architectural space leads to finding the secrets of the space enjoyment procedure (Soltanzadeh & Yousefi, 2017). For instance, a longer time is spent in spaces with high complexity than the other similar spaces, and residents allocate less time to spaces with the extreme simplicity of the plan geometry. various methods are available for understanding simplicity and recording the complexity of architectural spaces, and most of these analyses are observer-oriented. This means that observing inside this space is the main criterion for evaluating the simplicity and complexity of the space. Diffusibility, accessibility, spatial perception capability, spatial coherence level, spatial visibility level, etc. are some factors that can be used to examine spatial simplicity and complexity from the observer's view. In the current study, all main bases were identified by plotting the available spaces inside caravanserais, and each available space in the case caravanserais is displayed and analyzed in Table 2 based on their mutual connectivity and coherence.

Discussions

- **Typology of caravanserais in Esfahan**

Before the Safavid period, caravanserais constructed in Esfahan did not follow a specific geometry or order, lacking a definite pattern. The Chahar Borj caravanserai of the Ilkhani period in Esfahan owned a four-iwan plan with decorative towers and stone/brick materials, (Razavi, 2008) in comparison to the Chaharabad caravanserai related to the same period with an unordered hexagonal plan with stone and brick materials that do not follow any specific order. On the other side, the Chah Ghadeh 3 caravanserai (related to the early Islamic period) in the Ghahrud road was constructed with a different geometry from the Robat Ghamsar caravanserai belonging to this era. Esfahan province has a specific political and trading location in the Safavid period and was known as the populated city for land caravans and those who decided to travel and trade through the sea route. Most of the Silk Road caravans passed through this city, which is popular for welcoming passengers and trader tourists. Case caravanserais examined in Esfahan province (Chah Ghadeh 1, Hoseynijeh, Rivad Bostan, Toor, and Madarshah) are all intrinsic with a cruciform plan and a four-iwan construction pattern regarded in all cases, with complexities in the plan and geometry. In some of these samples, decorative towers are constructed around the four corners of caravanserais, and the Madarshah caravanserai has brick and ceramic works along with other decoratives. Brick and stone as construction materials are frequently seen in the case study caravanserais of Esfahan, with bricks and stones used in all and some cases, respectively. All these caravanserais have a massive central yard inside the caravanserai's main core in which rooms are located around this yard. The caravanserai spaces were accessed from only one path in the entrance doorway, and spaces were all restricted and closed.

- **Typology of caravanserais in Kerman province**

Before the Safavid era, a few caravanserais were constructed in Kerman province, and this small number indicates the low passage of trading caravans. On the other side, the lack of a defined and uniform pattern is observed among constructed caravanserais. In Shahr-e Babak, the Robat Gharb caravanserai (dating back to the beginning of Islam) is a sample construction with a different plan type without a four-iwan pattern, and the lack of a basic construction pattern relative to the climate, which is an important typology case of Kerman caravanserais before the Safavid era. Neighboring to Hormozgan province, Kerman province mediates easy access to open waters for marine trading, hence it was among the ideal provinces in the Safavid period for passage and use. Caravans aiming to trade through the sea route from the

Silk Road at the end period of the Safavid era passed through Kerman to Hormozgan provinces. The case caravanserais examined in Kerman province (Baghin, Biaz, Khane Sorkh, Sangto, and Kabotarkhan) all have an introverted rectangular plan with a four-iwan construction pattern in some cases, and a mountainous structure is met in other cases. These caravanserais have lower complexities in the general plan and geometry than the examined cases in Esfahan province. Among the examined cases, only the Sangto caravanserai in Kerman has decorative towers in four corners of the caravanserai, and other cases are constructed simply without decorations. In Kerman province, most construction materials include bricks and stones, with the former used in all constructions, and stone is used in some cases. Three cases of caravanserais have massive central yards in the main core of the caravanserai, and the other two cases lack a central yard with checkered rooms located in the main core of the building. Similar to the samples of Esfahan province, access to caravanserai spaces of Kerman province was through the entrance doorway, and spaces were all restricted and closed.

- **Typology of caravanserais in Hormozgan province**

Before the Safavid period, a few caravanserais were constructed in Hormozgan province. Maps of these caravanserais are not available in historical and architectural books. An important reason before this event was the slack status of marine trading as land trading paths did not reach Hormozgan province. Therefore, the study of caravanserais' typology in Hormozgan province after the Safavid era is of great importance.

Hormozgan province neighbors the open waters of the Persian Gulf and Oman Sea and entails the Hormoz port and Bandar Abbas, hence it is the most proper location for the marine trading of trader caravans. When marine trading boomed in the late Safavid era, expansion and dispersion of caravanserais were improved alongside trading passages in Hormozgan province. The case caravanserais of Hormozgan province (Badani 1, Badani 2, Badani 3, Berkeh Sefid, and Berkeh Soltan) were all extroverted with a cruciform plan. The construction pattern of these caravanserais follows that of the shores in the Persian Gulf and is free from any complexity in the plan, with a simple and ordered geometry. Decoratives inside and outside of the caravanserais are absent in the examined cases, all of which are simple with easy and rapid construction. Stones are frequently used in the construction materials of the case caravanserais in Hormozgan province, and bricks are not absolutely used in the buildings. A central yard is absent in the caravanserais, and all neighboring rooms to the outer walls have access to external space. In fact, spaces are not restricted and closed.

- **Complexity**

For a better evaluation of a spatial complexity nature, structures of the case caravanserais should be examined using the spatial perception capacity coefficient, which is a quantitative index that evaluates relationships between humans and the environment based on space configuration. In this method, space consistency and space uniformity are evaluated relative to each other so that space perception capability is defined by residents. The topological relationships between routes aid individuals to have an easier perceptional image from the architectural form in their mindset. In the end, the coefficient of determination of this value is the spatial perceptional coefficient that determines the observer's point of view. The high value of this index regarding an architectural space means that individuals and residents have gained a more proper perception of the overall structure and will not undergo challenges in routing and enjoying spaces. A higher coefficient of determination indicates a greater perceptional coefficient and spatial perception and, ultimately, the spatial complicity coefficient is lower. This method is used to evaluate the geometric complexity and simplicity of architectural space. By definition, the spatial perception index is a value between 0 and 1, and a spatial perception coefficient closer to 1 suggests the area range with higher perceptional capability, and, in fact, spatial complicity is lower in geometry. Kiaee et al. (2019)

used this flexible technique of spatial system in the internal space architecture of houses in Ghazvin City. In their research, flexibility signs (diffusibility, functional distinction, and spatial uniformity) are separated into traditional and contemporary forms. Maddahi & Memarian (2016) used the mentioned approach to analyze traditional houses regarding spatial configuration in Boshroyeh City. In the mentioned study, the continuance of residential architectural types was evaluated comparatively from the Safavid period up to the early Pahlavi period, and the space syntax technique was used to separate possible weaknesses in the lifestyle, changes, and emergence of new needs. In our case study samples, the coefficient of determination was obtained using simulation in UCL Depthmap software. The case caravanserais in Esfahan province gained the lowest numerical average of 0. 3 in allocating the quantitative spatial perceptional coefficient. The case caravanserais in Kerman province received a numerical average of 0. 43 with higher spatial perception than Esfahan province. A numerical average of 1 (the highest coefficient of determination) was obtained in Hormozgan caravanserais, which have higher simplicity than the other available spaces in Esfahan and Kerman caravanserais.

Conclusion

The examination of introverted or extroverted caravanserais' plans indicates the desirability of access hierarchy in different spaces in the environment. Extroverted plans indicate a high use rate of caravanserais' spaces. Introverted plans have their own complexities that decrease the employment rate of different spaces in caravanserais. The type of construction materials used in caravanserais is rooted in the construction method and the relevant climate. On the other side, the use of materials with high-speed construction indicates the necessity for the rapid construction and employment of caravanserais. Geometry and spatial complexity are dependent on the application patterns of caravanserais' spaces. Caravanserais that need a high speed in spatial employment apply simple spatial patterns with simple geometry due to the high passage of caravans. The examination of connectivity and spatial coherence in the inner spaces of caravanserais indicates the depth of complexity and spatial perception of users of buildings. Trading caravans with quick travels need spaces with a high perceptional coefficient to utilize available spaces with the lowest loss of time.

As the largest trading network in the Safavid period, the Silk Road plays a major role in the physical changes of in-transit constructions, including caravanserais. On the other side, trading paths have extended toward the southern borders of Iran because of factors such as insecurity in western borders, the development of shipping in the Western world, and the low cost of marine trading. This change in the trading path has affected the typology of caravanserais. Changes in the trading path from northern Iran with cold/mountainous, and warm/temperate climates toward the south of the country with mainly hot/dry and warm/wet climates, as well as the humid climate of southern coasts, have caused major changes in caravanserais' plans. The geometry and complexity of spaces were also affected by the mentioned main signs such that complicated structures in central and northern parts of the country (the land path of the Silk Road) have transformed into geometric structures of a simple plan with high perceptional capability in southern Iran (the marine path of the Silk Road). Changes in structures have changed the form of caravanserais, and the dynamicity of trading travels indirectly affected the building structure, granting them a simpler form. This sensible change in caravanserais' construction form was caused by the high rate of trading in the types of southern coasts in which the building was accessed from multiple entrances (extroversion). However, the four-iwan types of caravanserais in central Iran, which mostly contained a yard, the construction was accessed through only one entrance (introversion).

Furthermore, more facilities of caravanserais in Esfahan, which was the cultural and political capital of Iran where more concern was dedicated to the safety of roads, led to traders' interest in these caravanserais. Hence, it can be concluded that the location of caravans' trading paths based on the principle of selecting the

best and easiest trading route was important in the Safavid period. Moreover, the plan and geometry of Esfahan caravanserais are more complicated than those of Kerman, whose caravanserais have more complicated geometry and plan than sample cases in Hormozgan province. This complexity is one of the components related to land trading through the Silk Road. Nonetheless, this complicity in the plan geometry decreases close to marine trading paths of the Silk Road, and simpler order replaces complexity. Bricks and stones are the major construction materials in the case caravanserais of Esfahan and Kerman, in which brick and stone are used in all and some cases, respectively.

Hormozgan province is located in the passage path of marine trading of the Silk Road that underwent various changes in the plan of buildings, especially caravanserais because it was affected by a large volume of caravanserais all at once in a short time. Neighboring with Hormoz and Bandar Abbas ports caused booming marine trading in this province while passing through the Silk Road. The high spatial perception coefficient in the analyses of Hormozgan province caravanserais is a significant sign of this simplicity. The frequently used construction materials in the case caravanserais of Hormozgan province are stones and bricks.

A notable and novel point is that the structures of case caravanserais in all three provinces underwent fundamental changes in the structure and order before and after the Safavid era. A definite pattern and order were absent in the structures of caravanserais before the Safavid period, including the caravanserais in the Ilkhani and Islamic periods; even the climate played an insignificant role in forming the physical spaces of these constructions. However, the structures of constructions for trading became patterned and engineered along with construction in the Safavid period and afterward.

Ultimately, the consolidation of studies allows for plotting the diagram of relationships between trading signs in the Safavid period and caravanserais' structures and applying the results to the case caravanserais in Esfahan, Kerman, and Hormozgan provinces, as described in Fig. 4.

The findings of this research are complementary to previous studies. Other researchers, such as Pouya (2014), mentioned the impacts of various factors on the rise and fall of trading in the historic course of the Silk Road from the emergence time in the Sasanid era to the falling period in the middle of the Safavid era. However, they did not provide precise information on changes in structures related to these transformations. This study attempts to continue this research trend using new spatial methods to fill the research gap related to changes in the trading paths of the Safavid period and their effects on architectural structure transformation.

A review of related literature demonstrates that the findings of this research are in line with previous studies. For instance, Talebian (2016) similarly demonstrated that dependent complexes and the diversity of sensible and insensible inheritance, which were directly related to the presence of cultural and trading paths, could dramatically influence historical signs and constructions, historic yards, historical villages and cities, traditional architecture,

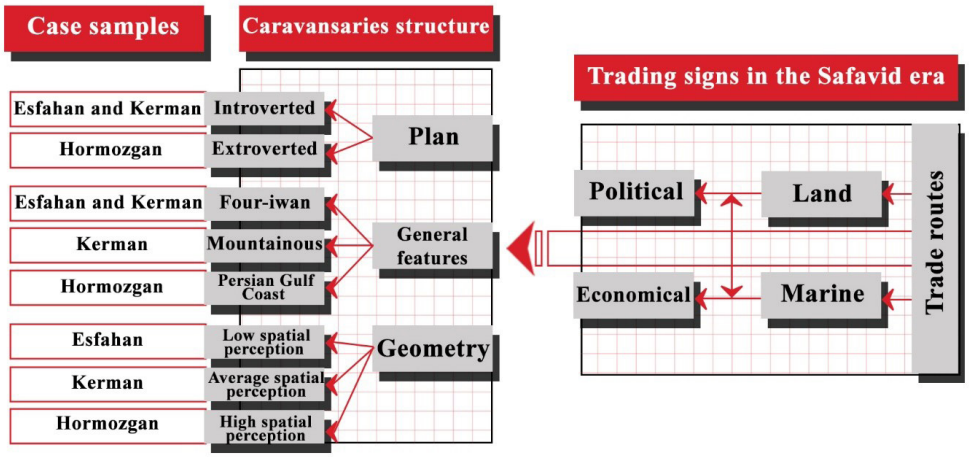

Fig. 4. The relationships between trading signs in the Safavid era and case caravanserais' structures. Source: Authors.

industrious and modern inheritance, public constructions, cultural-natural views, transportation tools, and other evolutional samples. Nevertheless, previous studies drew such a conclusion based on field observations, library studies, and analytical-descriptive methods. In our study, however, spatial analytical methods were used to examine this subject, and previous studies were confirmed using quantitative data. Consequently, the current study endorses the assumption that changes in trading paths in different periods, such as the Safavid period, could affect the structure transformation of constructions, including caravanserais. An innovation of this study is in the use of new and innovative tools to analyze the typology issues of historic architecture. Future studies can follow the method used in this study to analyze similar issues. The previous investigations are based on typology and climate constraints, and future studies are suggested to focus on extended geographical ranges and new techniques that examine changes in trading paths. Additionally, it is suggested to use new interdisciplinary sciences, such as computational social science, in proposing a single pattern.

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