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The Impact of Spatial Changes of Shiraz's Historic District on Perceived Anti-Social Behavior

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Abstract: As cities grow, their spatial configurations may undergo some changes over time. This study attempted to examine the impact of the changes that occurred to the spatial configuration of the historical district of Shiraz on perceived anti-social behavior (ASB). Space syntax techniques were used to assess whether they can explain the extent to which perceived levels of anti-social behavior were impacted by these changes. Historical and present maps of the city were obtained and spatially analyzed using DepthmapX. The perceived ASB was assessed using seven groups of factors identified from the existing literature. These factors were evaluated using questionnaires distributed to long-term residents living in the area; in total, 98 respondents responded to the questions using a five-point Likert scale. Findings demonstrated that the perceived ASB was concentrated along highly integrated street segments. The unplanned transformations also introduced a large number of fragmented street segments, making it a challenge to connect the inner streets to the rest of the city. The spatial metrics used in this study could provide a useful tool for planners, urban designers, and policymakers, who can thereby measure the impact of proposed city modifications on social behavior and the residents' quality of life.

Keywords: space syntax; built environment; anti-social behavior; sustainable planning; spatial configuration

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1. Introduction

Numerous studies have criticized the lack of definitions of anti-social behavior (ASB) [1,2]. ASB has been broadly defined as behavior that violates the basic rights of others [3] or as creating a nuisance and disorder that makes the lives of other people a misery [4]. While ASB is different from what is known as an anti-social personality disorder (ASPD) (a clinically diagnosed form of mental health disorder), there has not been a clear definition of what constitutes ASB [5,6], although criminologists view it as a low level of criminality [6]. The term was originally introduced by Millie [6] to represent a form of public disorder in public spaces. In the United Kingdom, the 1998 Crime and Disorder Act, the 2003 Anti-Social Behavior Act, the 2014 Anti-Social Behavior Act, and 2014 the Crime and Policing Act were all introduced as a response to concerns about the damaging impact that anti-social behavior had on communities [7]. Such acts gave authority to the police to address various levels of ASB, such as leaving graffiti, gang activities, harassment, noisy neighbors, littering, begging, drunkenness, or even dispersing groups of two or more in public places if their presence is intimidating to others [6,8,9].

There is a wide spectrum of incivilities that may lead to a further decline in the quality of life and well-being, behavior that generates more than just distress [10], promotes fear, and even encourages crime [11]. Although classifying particular behavior as a form of ASB is dependent on people's tolerance levels and expectations, ASB may be considered harmful, whether or not it is offensive [10]. Signs of vandalism and graffiti, for example, may increase the fear of crime [12]. Although the fear of crime does not necessarily lead to crime, both crime and the fear of crime may still be seen at particular times and places [12].

A number of crime-place scholars have demonstrated a strong link between the spatial properties of urban environments and ASB [13]. Scholars who examined the impact of spatial configuration on pedestrian movement patterns argued that spaces that lack supervision can in turn facilitate crime and different levels of public nuisances, regardless of their sociodemographic status [13–15].

The present study contributes in some ways to the emerging literature that discusses the role of the spatial environment in creating opportunities for what is perceived as ASB. More specifically, it investigates whether spatial configuration has an impact on the perceptions of ASB. Because ASB is dependent on the subjective emotional responses of people [9], as well as the social and cultural norms of aesthetic acceptability [6], this study examines broadly how the perceived levels of ASB are connected to the spatial configuration of the city among longtime residents of Shiraz, a major city in Iran. In this way, we attempt to answer the following questions: (1) How are various dimensions of ASB structured spatially in a city? (2) How do the syntactic qualities of physical modification contribute to creating micro-spatial patterns of ASB within cities?

Shiraz was selected as a study area because of its historical significance and because of the significant physical modifications that have occurred over the past fifty years. We followed Hiller and Hanson's [16] space syntax techniques to quantify the accessibility levels of street segments within the historical district of Shiraz and connected those syntactic values to responses that we gathered from long-term residents. This study contributes to the emerging scholarship in the city of Shiraz and is useful to architects, urban designers, and policymakers since space syntax could be a valuable tool in understanding the impact of their work on different behavioral outcomes.

2. Literature Review

2.1. Theoretical Framework

Regardless of what constitutes ASB, the rational choice theory scholars argue that certain qualities of the physical environment may impact the decision to commit an offense, based on a cost and benefit analysis [17]. Individuals who decide to commit ASB weigh their options from the perspective of benefits, risks, and the costs associated with such acts. From a visibility point of view, the decision to commit any type of offense may be impacted if one is exposed to or intervened by controlling agents such as pedestrians, security personnel, or residents. Cohen and Felson [15], founders of the routine activity theory, argued that offenders will look for places that are not maintained and that lack supervision, such as those areas occupied by renters, vacant lots, or abandoned structures [18]. Hollis, Felson, and Welsh [19] also suggested that the presence of a human element in the space may intentionally deter the offender from committing an offense in a certain place.

Jane Jacobs had written about urban redevelopment for decades before the publication of her masterpiece, *The Death and Life of Great American Cities*. Her "eyes on the street" theory is widely cited in crime-place research. Jacobs supported the notion that sidewalks must continuously have users on them and must have people watching these sidewalks from their buildings [20]. Oscar Newman's "defensible space" theory has also received the same scholarly attention within the crime-place field. In his book, *Defensible Space*, Newman argued that a hierarchy in transitioning from public spaces to private spaces must exist for residents to be able to detect and report behavior that is perceived as unacceptable [21]. While several criminologists supported the importance of supervision in deterring individuals from committing an offense, the question remains, what urban qualities will generate enough of a co-presence to make these sidewalks safer? What street characteristics will drive more people to frequent them? It makes sense, then, to assume that offenders will refrain from committing any type of anti-social behavior if the street is being watched by people. While much attention has been given to what factors lead to ASB, such as neighborhood conditions, unemployment, and income levels, little attention has been given to demonstrating the role of the built environment in facilitating such behavior.

2.2. Anti-Social Behavior and Space Syntax

Originally introduced by Hillier and Hanson [16], a space syntax is a group of theories that explain how spatial configuration can impact a range of human behaviors. The theory originated in presenting a reliable tool to assess the syntactic properties of different spatial configurations. For example, integration is a space syntax measure that was introduced to assess how easy it is to reach a certain segment of the street from any other part of the city. Connectivity is a commonly used measure that looks at the number of intersections a street segment has. Intelligibility is another measure that evaluates the legibility of a neighborhood or a city. All three measures have been widely used to objectively explain a range of behaviors.

Over time, space syntax theory has been used to recognize the impact of spatial properties on social behavior and pedestrian movement patterns. Lee and Seo [22], for example, analyzed walking surveys for 10,000 locations in Seoul and found that walking volume was highly correlated with integrated routes in residential areas when controlling for other environmental measures, such as accessibility to public transportation, employment density, or zoning uses. Long, Baran, and Moore [23] compared two neighborhoods in China, in terms of integration and intelligibility. In their experimental study, the researchers recruited 49 participants to assess the legibility of these two neighborhoods and test the participants' recollection of landmarks. Not surprisingly, this highly intelligible neighborhood was perceived as more legible. Additionally, residents tended to recognize landmarks that were located along integrated routes. In another study, Zerouati and Bellal [24] analyzed four mass-housing neighborhoods using space syntax; they found that social activities (such as interacting, playing, and chatting) took place in the least-connected spaces. Of relevance to this study, Askarizada and Safari [25] also used space syntax to geocode the observed movement of people in space in a city in Iran. Their findings showed how many people were observed to socialize along the less integrated routes that were connected to landmarks of significant value, such as the bazaars. The authors conclude that these types of social interactions in urban spaces can create positive social norms, improve the well-being of the inhabitants, and reduce the opportunities for crime and the fear of crime.

While a number of studies demonstrated a strong link between the space syntax measures of connectivity and integration with different types of crimes (see [26–29]), a limited number of studies examined the distribution of ASB incidents using space syntax. Friedrich, Hillier, and Chiaradia [13] analyzed the spatial distribution of two years of reported ASB incidents in two London boroughs that were later subdivided into neighborhoods, with distinct street patterns and housing types. Their findings showed that ASB incidents were concentrated along highly integrated street segments within street-based neighborhoods (where the spaces of the streets are defined by the building frontages of terraced houses). ASB incidents were also concentrated within the least integrated street segments in estate-based neighborhood layouts (a tree-like layout with cul-de-sacs and free-standing buildings).

The above-referenced studies suggest that buildings can be designed in a certain way to control or decrease ASB. According to these types of studies, areas with hotspots of disorder may be recognized by their spatial properties. However, the perceptions of residents become important in recognizing these types of incivilities. The objective of this paper is to understand whether a relationship exists between space and the heightened perception of ASB from the perspective of long-term residents who experienced significant changes in the urban configuration of their city. Since the syntactical model of the spatial analysis presented by space syntax linked the configuration of the space to movement patterns and activities in space [30], then, one can infer that bringing people together in certain spaces may also explain why ASB is perceived in certain places over the others.

2.3. Anti-Social Behavior Measures Used in This Study

As discussed earlier, ASB includes a wide spectrum of behaviors that may be harmful to people, depending on their subjective emotional responses and cultural values. Since

ASB may be perceived differently across different cultures, following Glaser's [31] method, the lead author met with two researchers with expertise in Shiraz, to conduct an in-depth review of the literature and to extract potential themes that could be culturally applicable to Shiraz. Any literature discussing ASB and that was published between 2012–2022 in databases like ProQuest, Scopus, the Web of Science, and JSTOR were examined. After a consensus was reached, the following themes and sub-themes were extracted and were used as the basis of the questionnaire (see Table 1):

(1) The spatial-physical indicators combine themes that are perceived to present opportunities for ASB. Examples include the perception of physical separation, spatial proportion and human scale, the permeability of the site, the usability of space, and the physical properties of space.
(2) The security indicators measure the levels of co-presence among people on different street segments. According to Hillier and Sahbaz [32], the presence or absence of social interaction and their co-presence in space may impact the levels of ASB.
(3) The identity and sense of place indicators highlight several factors related to one's sense of orientation in space, one's adaptation to form and function, visual clarity, and ease of wayfinding. As Askarizad and Safari [25] demonstrated in their research on another historic city in Iran, legible urban spaces improve social interactions among residents, which may, in turn, improve the sense of ownership and could claim the space back to improve its safety.
(4) The urban indicators assess landscape aesthetics and attractiveness, visual impact, and the perception of visual pollution, as well as the lighting quality during the nighttime.
(5) The environmental indicators measure perceptions of the cleanliness of the environment, the presence of street furniture, perceptions of the visual disturbance of views, the daytime and nighttime use of light, perceived levels of noise pollution caused by activities, and vandalism.
(6) The functional indicators assess the perceived quality of activities in the space and the role of the space in creating opportunities for socialization, as well as perceived levels of decentralizing land use in specific locations.
(7) The social indicators measure the perceived levels of social interaction and social trust.

Table 1. The indicators related to ASB.

Indicators	Theme	References
1. Spatial-physical indicators	Perceived physical separation, spatial proportion, human scale, permeability to the site, the physical properties of space, geographical location	[29,33–38]
2. Security indicators	Segregation, co-presence, social interactions, community engagement	[34,39,40]
3. Identity and sense of place indicators	Sense of orientation in space, visual clarity and ease of wayfinding, adaptation to form and function	[25,41]
4. Urban indicators	Lighting, aesthetics, visibility	[42–45]
5. Environmental indicators	Littering, noise, maintenance, damages	[9,37,45–49]
6. Functional indicators	Social activities, land-uses, placemaking	[9,37,44,46–51]
7. Social indicators	Social cohesion, informal social control, social trust	[39,46,52–56]

3. Methods

3.1. Case Study

The study area is the historic district of Shiraz city, the fifth most populous city in Iran, with a population of 1,781,707 in 2016. The city dates to 2000 BCE [57]. The city is one of

the oldest cities in Persia and is home to two UNESCO world heritage sites. It is mostly known for its rich history, culture, mosques and bazaars, and major pilgrimage sites [58]. This site was selected for several reasons. Firstly, the lead author had access to the site. Secondly and most importantly, Shiraz has undergone physical changes that have impacted its configuration over the past fifty years (see Figure 1). The impact of these changes on the city has been the subject of several studies. Bagheri and Tousi [59] have discussed at length the reasons leading to the urban sprawl in the city and the conversion of non-urban land to urban land use, to accelerate its growth. The physical expansion of Shiraz seemed to destroy its historical context and reduce its urban environment quality [60]. Masoumi [61] examined the historical cores of major Iranian cities. He found that the historical districts typically consisted mostly of dead-end alleys and curving main routes that connected different areas together, making it possible to walk or cycle everywhere. After the transformation, city-level accessibility within the historical district has become worse than it was in the sprawling areas on the periphery of the cities. Among the long-term residents, the city has become known for having two different structures. While the old structure houses the city's historical landmarks, the new structure that supported the newly developed road infrastructure, with the intention of enhancing vehicular traffic, may have led to breaking the road connections between the historic landmarks. Social interactions among residents have also been impacted, which may have led to a decline in population, as explained in the next section [62]. Shiraz is now characterized by inconsistency in the continuity and widths of its sidewalks, ornamentation, and lack of accessibility to retail areas, green spaces, and entertainment facilities [63]. However, according to their research, Bahrainy et al. [63] showed that residents' walkability in Shiraz was impacted by their perception of safety and architectural aesthetics, as well as comfort and attraction.

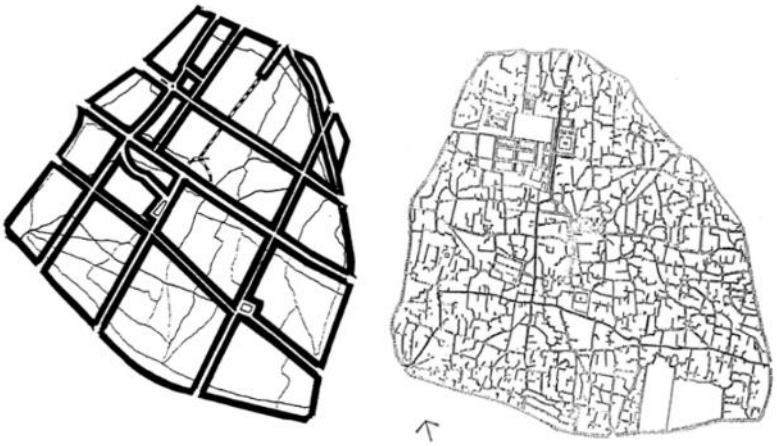

Figure 1. A present map of the historic district (**left**) and the original map of the historic district (**right**). The arrow represents the North direction.

The historical configuration of the old city began during the Pahlavi dynasty in 1957 and grew to what now comprises the city limits of Shiraz—moving the limits from northwest to southeast. The historical part has remained intact since the 18th century. While the city limits expanded in terms of area, the population grew elsewhere in the city, pushing long-term residents to migrate from this area to settle in other parts of the city. The population continued to decline in the historical district until the present day, due to a decline in the quality of life, a lack of urban facilities, the loss of cultural and social homogeneity, physical deterioration, and an increase in unwanted behavior. Table 2 summarizes the decline in population in the historical district and the increase in Shiraz from 1864 to 2017. The authors collected this data using different sources, such as the comprehensive plan for the city, the demographic data available in the Statistics Center of Iran, and two theses that were published at Shiraz University [64,65]. Figure 2 show the current distribution of landuses.

Table 2. Population and area changes in Shiraz from 1927 to 2017.

Year	Population			Area (Hectare)		
	Historic District	Other Parts of the City	Shiraz City Limits	Historic District	Other Parts of the City	Shiraz City Limits
1864	45,000	-	45,000	378	-	378
1882	53,607	-	53,607	378	-	378
1899	71,254	-	71,254	378	-	378
1927	101,974	-	101,974	378	-	378
1938	119,800	-	119,800	378	-	378
1944	129,000	-	129,000	378	-	378
1957	102,395	68,264	170,659	378	1231	1609
1967	115,267	148,327	263,594	378	3162	3540
1977	139,120	255,240	394,360	378	12,720	13,098
1987	88,042	748,013	836,055	378	17,280	17,658
1992	79,968	893,193	973,161	378	18,189	18,567
1997	75,637	977,388	1,053,025	378	19,725	20,103
2007	59,438	1,396,065	1,455,503	378	21,292	21,670
2017	35,727	1,529,845	1,565,572	378	22,353	22,731

Figure 2. A present-day map of the historical district, showing the distribution of land uses (blue for landmarks or tourist sites, green for parks, red for retail, and black for the housing district).

3.2. Questionnaires

Since there have not been any previously documented studies on the occurrence of ASB in Shiraz, a questionnaire was developed and distributed to residents who lived in the historic district. The questionnaire was based on the indicators summarized in the previous section. For example, for the spatial-physical indicators, residents were asked to rate whether the entrance to their neighborhood was well defined, their perception of the accessibility level of their residence within the historical district, and the perceived desirability of the main passageways, as well as the location in relation to their city. For the second category, the security indicators, the questions addressed residents' perceptions of safety in their neighborhood, their perceptions of feeling safe while walking alone during the day or the night, and the perceived levels of ASB and co-presence. For the third indicator, identity and sense of place, the questions explored residents' perceptions of the sense of place in keeping out ASB, whether they were willing to move to other parts of the city, the familiarity of the space, their interest in living in the historical district, and the reputation of their neighborhood. The urban landscape indicator included questions that assessed residents' perceptions of safety, tranquility, and aesthetics, their perceptions of whether the appearance of the area is desirable, and any signs of violence or any form of nuisance behavior, such as glass-breaking, graffiti or slogans, the visibility on sidewalks and in passageways, and the role of light in preventing anomalies. The fifth indicator, the environmental indicator, addressed questions related to garbage dumping, grounds upkeep, light levels at night, or noise disturbances, along with maintained amenities, street furniture, surface conditions, and trash bins. The functional indicator included questions related to their activities in the neighborhood (both permanent and seasonal), the existence of spaces that increased the sense of safety, such as parks and libraries, and the existing land uses. Additional questions addressed their perceptions of whether having a job and earning a living can prevent anomalies, and whether age and gender can affect the incidence of anomalies. The final category was a social indicator that assessed the levels of social cohesion, the presence of strangers, whether the respondents knew their neighbors well, and whether they contribute to the safety of their neighborhood.

In general, there was a total of 41 questions, formed on a five-point Likert scale. Two questions were removed to improve the reliability of the Cronbach's alpha test. The number of questions that addressed each category ranged from 4 to 7 questions per category. According to the results of the reliability test, Cronbach's alpha coefficient was 0.761 for the spatial-physical scale (5 questions), 0.758 for the security scale (6 questions), 0.783 for the identity and sense of place scale (5 questions), 0.732 for the urban landscape scale (5 questions), 0.730 for the environmental scale (5 questions), 0.723 for the functional scale (6 questions), and 0.701 for the social indicator scale (7 questions), which indicated a high internal consistency.

The lead author distributed the questionnaires in person between September and October 2018. The lead author randomly distributed the questionnaires to passers-by who had lived in the historical district for at least 30 years. In 30 days, only 98 residents agreed to respond to the questionnaires. Given their length of residency, all respondents understood the objectives of the research and the nature of the transformations that had occurred in the historical district. None of the questions contained identifiable data. The questionnaires focused on questions related to the seven categories referenced earlier. The location of each questionnaire, however, was geocoded into ArcGIS9.3 for further analysis.

3.3. Space Syntax Techniques

In this research, the city limits of Shiraz were analyzed using a space syntax technique known as axial map analysis. This type of analysis requires the researcher to flood-fill all the spaces between buildings with the longest and fewest lines of sight. A total of 21,730 axial lines were drafted manually. using Autodesk AutoCAD. The resulting axial map was later exported into DepthmapX v0.5 [66], a software developed by University College London that can perform different types of space syntax techniques. To facilitate

analysis, DepthmapX assigned a unique ID for each resulting axial line. DepthmapX can run various space syntax measures, such as integration, connectivity, and intelligibility. Furthermore, the software creates a heatmap of all the resulting measures, to further aid visual analysis.

In this study, the researchers examined three commonly used space syntax measures that were associated with crime, as reviewed earlier. These were local integration (known as R3), global integration (known as Rn), and intelligibility. In general, integration represents the average number of steps needed to get to a certain axial line from all the axial lines in the system. A highly integrated line is one that can be reached from all the lines in the system in the fewest number of steps. The local integration measures space up to three steps away, while the global integration measures spaces in the entire city (e.g., the city limit). Generally speaking, integration was shown to be associated with a human presence in space or with generating more activities, since these highly integrated lines were within easy reach [67,68]. Intelligibility values are computed by calculating the ratio between the number of lines intersecting an axial line and its global integration value [68]. Previous research indicated that neighborhoods with intelligibility values that were higher than 0.5 were shown to be easier to navigate and to remember than those with lower intelligibility values [23]. In a recent review of studies related to intelligible communities, Peponis [69] showed that syntactic relationships are helpful in constructing cognitive maps of street environments and in aiding wayfinding strategies. Peponis and Hillier et al. [69,70] suggested that legible environments are responsible for the distribution of movement and co-presence in public spaces, which is linked to reducing stress and reducing the perception of crime [71,72]. Within the context of this research, integration could be a useful measure to understand the role that spaces play in the historical district of Shiraz on the reported levels of social control and supervision, as well as ASB [73]. Intelligibility is also a good measure for assessing the imageability of the city. Intelligibility values closer to zero are an indicator that the city is fragmented.

3.4. ArcGIS and Statistical Analysis

After the completion of the axial line analysis using DepthmapX, all the axial lines, along with their associated results of local and global integration values, were exported into ArcGIS v9.3 and were amended according to each survey response. The final database was then extracted from ArcGIS for further analysis, using the statistical software SPSS. The unit of analysis in this research was the survey respondent. The average mean of each category was computed before running the correlational analysis between the reported perception of ASB and the syntactic values associated with the location of the respondent.

3.5. Kriging Interpolation Method

As discussed, the mean data of the variables that made up each of the seven groups of indicators was geocoded into ArcGIS. An interpolation analysis was then performed using the Kriging method. This is a popular geostatistics method that delivers a measure of confidence of how likely the prediction of what is being measured is true. In other words, the interpolation method predicts unknown values for cells in any given raster format, using a limited number of sample data points [74]. Figure 3 shows the spatial measurement of the data extracted from the questionnaire for each of the seven groups of indicators, where the red areas have the highest values (most favorable responses) and the blue areas have the lowest values (least favorable responses). Note how the sense of safety measure is mostly concentrated along the top left quadrant of the historic district, while the highest spatial-physical values are concentrated along the major axis, as demonstrated later in the paper (see Section 4.3).

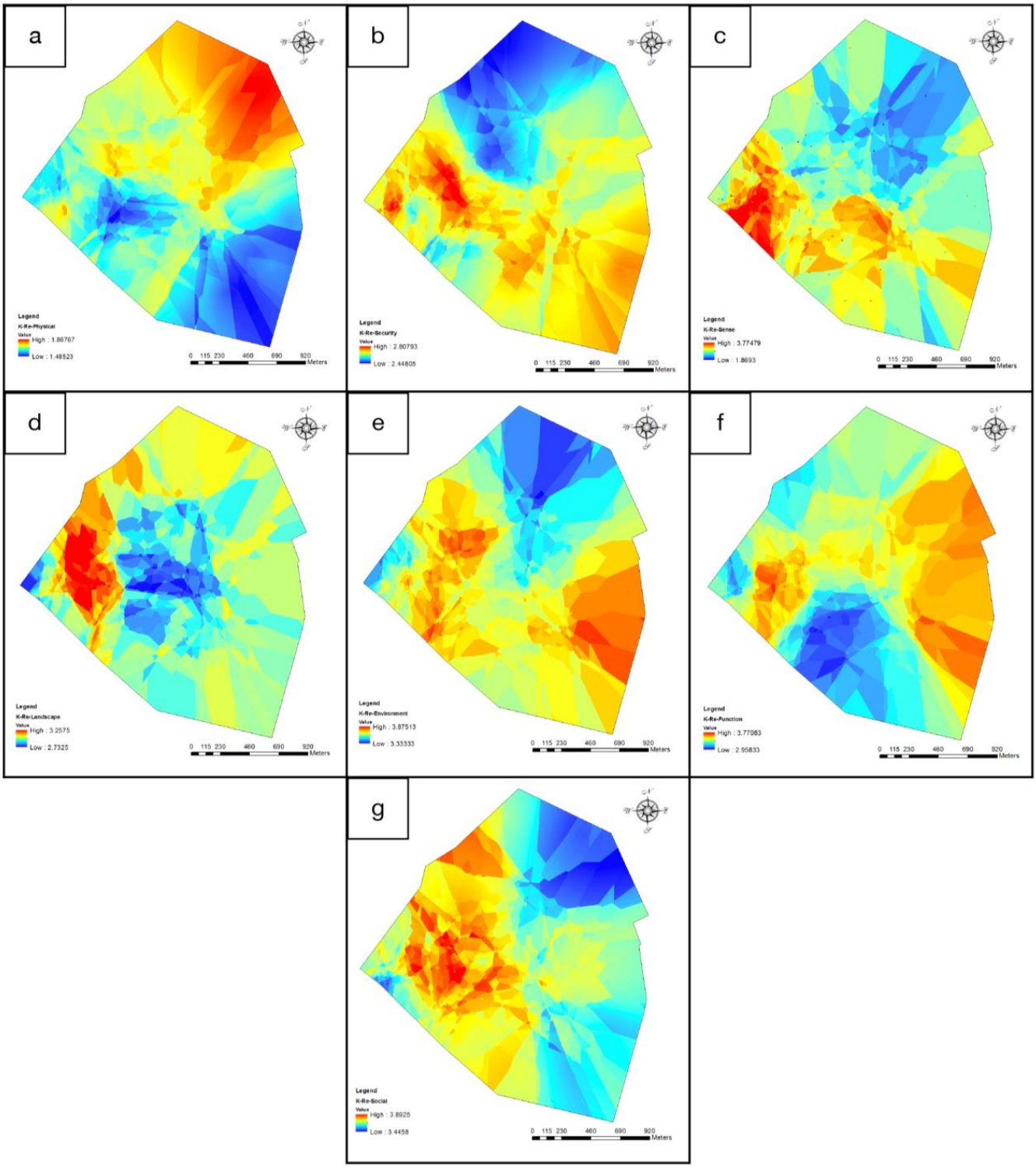

Figure 3. The results of the Kriging interpolation method, performed on all seven groups of indicators, were as follows: (**a**) spatial-physical indicators, (**b**) security indicators, (**c**) sense of place indicators, (**g**) urban landscape indicators, (**d**) environmental indicators, (**e**) functional indicators, and (**f**) social indicators.

4. Results and Discussion

4.1. Intelligibility

Intelligibility measures were computed for both the historical district, circa 1794 (the last year of the Zand dynasty) and the present configuration of the historical district. Intelligibility produces values of between 0 and 1. The intelligibility value of the historical district was found to be 0.2 in the past (circa 1794), and 0.04 during the present time, after the physical modifications to the spatial configuration of the historical district. This significant change indicated that the new urban transformation of the city created a fragmented street network. In line with previous research [23], the upgraded layouts caused challenges in wayfinding, making it more difficult for residents to socialize or for tourists to visit the several historical landmarks for which Shiraz is known.

4.2. Local and Global Integration (Historical District and the City Limits)

Table 3 displays the results for the local and global integration values within the historical district and the city limits (both past and present). If one makes a comparison between the current and the past configurations of the historical district, both global and local integration had higher values before the 1950s. As demonstrated in the previous section, intelligibility was also stronger for the earlier spatial configuration, when compared to the present form. These results provide strong evidence that the physical modifications that were implemented in the city weakened its street network connectivity, as well as its legibility.

Table 3. The comparison of integration value in city and context, in R_3 and R_n radii.

Scale	Measure	Min	Max	Mean	Std. Dev.
Historical District (past)	Global integration (Rn)	0.29	2.41	1.13	0.21
	Local integration (R3)	0.29	5.15	2.03	0.8
Historical District (present)	Global integration (Rn)	0.4	1.46	0.87	0.16
	Local integration (R3)	0.33	4.36	1.29	0.632
City Limit	Global integration (Rn)	0.2	1.72	0.87	0.182
	Local integration (R3)	0.33	4.77	1.66	0.704

To elaborate, the most integrated axis is now located in the center of the city, and it crosses the historical district. Figure 4, which represents the global integration (Rn) values, shows that the most integrated axial line had a value of 1.723. It crosses the historical district while also allowing a few other highly integrated axes to connect to it. This axis has become the main axis of the city and connects major historical landmarks, such as the Vakil Bazaar, the Vakil Mosque, the Vakil Bath, and the Arg of Karim Khan. The lowest value for global integration was found to be 0.201, indicating a higher value of depth. This line was found to be significantly isolated from other highly integrated lines, suggesting the difficulty of connecting other parts of the city to major landmarks.

Local integration, R3, was also computed, as shown in Figure 5. In this radius, the maximum local integration value was 4.77 and the lowest value was 0.333. Local integration values were most likely impacted by the nature of the main axis that connected different parts of the city, making the red spectrum visible within different parts of the map.

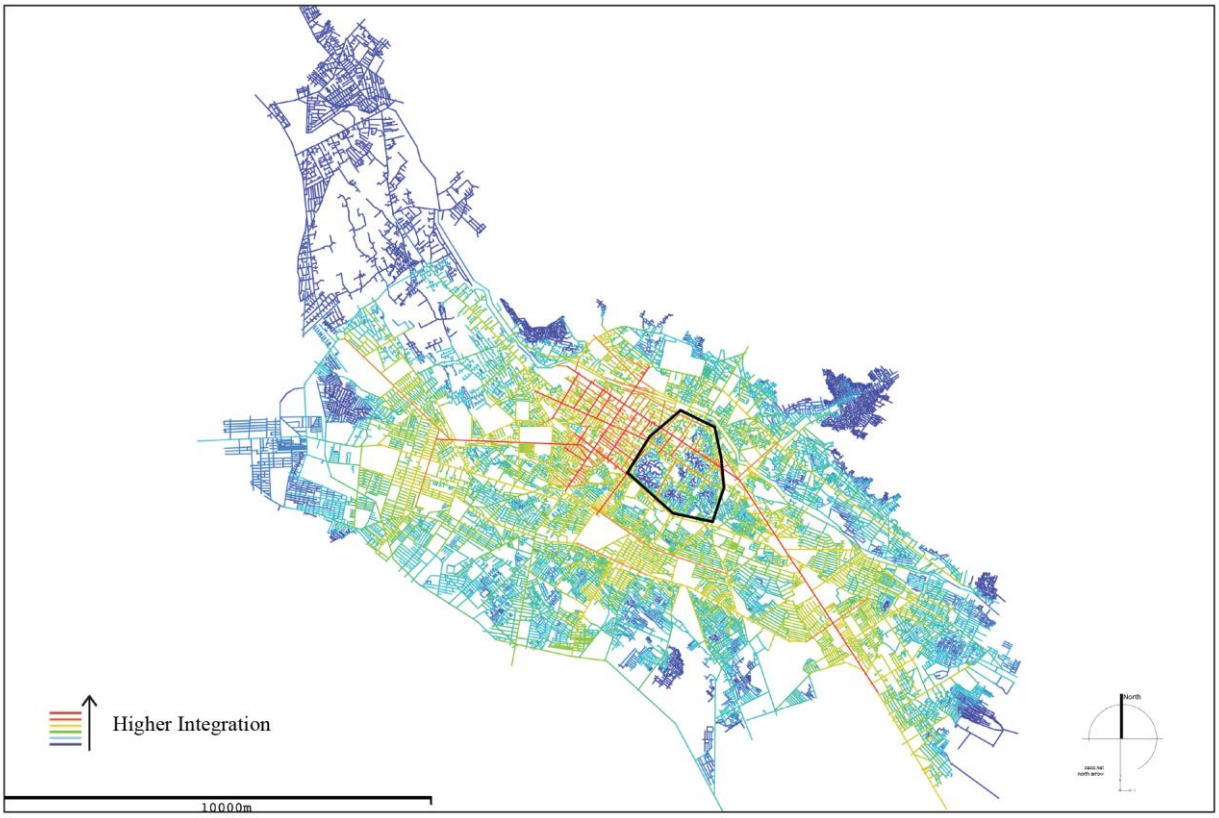

Figure 4. Axial map of Shiraz city limits, showing the results for global integration, Rn.

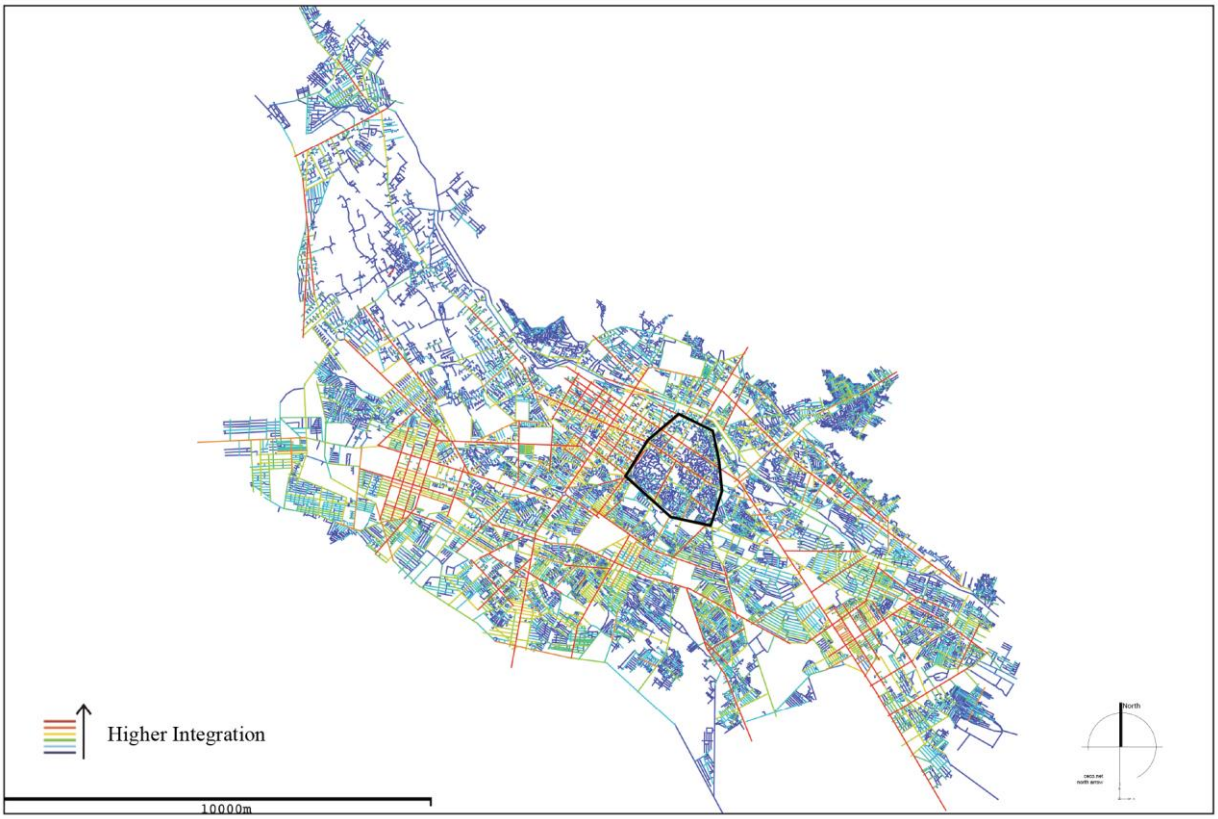

Figure 5. Axial map of Shiraz city limits, showing the results for local integration R3.

Although the highly integrated main axis of the city crosses the historical district, most of the street segments within the district have become segregated over time, as seen in the values before and after the transformation. Major landmarks that have significant cultural values in Shiraz, such as the Vakil Bazaar, the Vakil Mosque, the Vakil Bath, and the Arg of Karim Khan have become disconnected from other parts of the historic district, as demonstrated in Figure 6. Over the years, it has become a challenge to visit and socialize at these historical landmarks, as the streets have become fragmented.

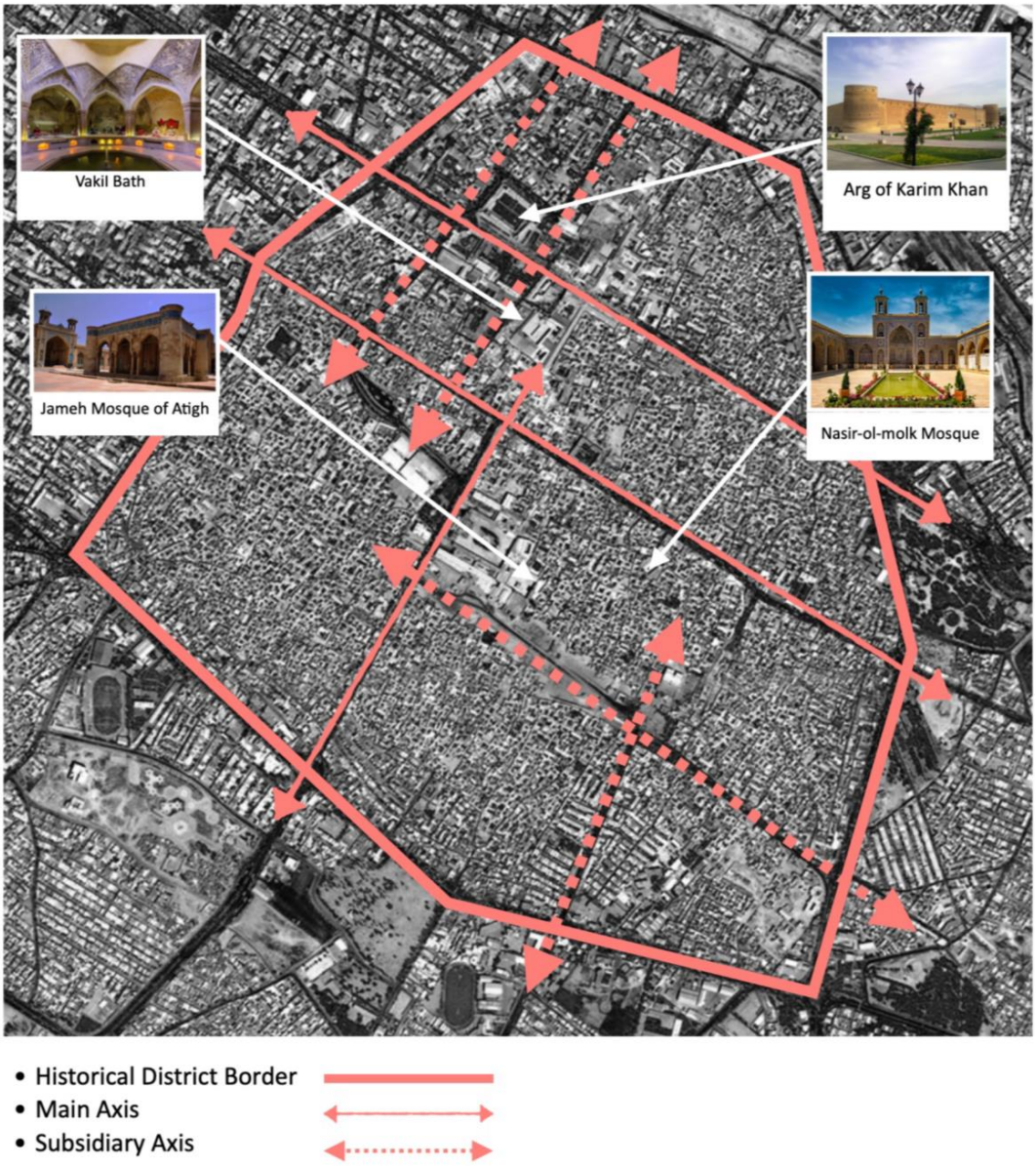

Figure 6. The location of the major historic landmarks in Shiraz.

Figure 7 (left) displays the global integration results for the historical district (present time). Although the main axis that crosses the center of the district is highly integrated, as shown earlier, other axes are extremely segregated. These areas can potentially attract unwanted behavior, such as ASB, due to the lack of co-presence and social control. There is a clear lack of transition from the public to private zones. According to Newman's defensible space principles, it becomes difficult to claim territoriality in these areas. In this radius, the highest integration value was 1.46 and the lowest was 0.49.

Figure 7. Global integration (**left**) and local integration (**right**) of the current historic district.

Figure 7 (right) shows the local integration (R3) output for the present historical district. In R3 output, the highest integration value was 4.36 and the lowest was 0.333, indicating a structural breakdown of the historical district since street segments have become deeper or have moved further away from the main axes. After a quick comparison between Figure 7 (left) and (right), one may observe a broad spectrum of deep blue lines that can impact the levels of co-presence and guardianship along the highly integrated axis. In comparison, Figure 8 (left and right) displays integration levels before the changes that were balanced, with a clear gradation between public and private zones, echoing Newman's principles of defensible space.

Figure 8. Global Integration (**left**) and local integration (**right**) of "past" historical district.

4.3. Correlational Analysis

A Pearson product-moment correlation was run to determine whether a relationship exists between integration and any of the seven ASB groups of indicators. The results in Table 4 showed that there was a positive correlation between global integration and spatial-physical indicators, and a negative correlation between global integration and five of the ASB indicators (functional, environmental, security, landscape, and sense of place). All correlations were statistically significant ($n = 98$, $p < 0.05$).

Table 4. Correlational analysis output.

Criterion	INT_Rn	Environmental Indicators	Functional Indicators	Landscape Indicators	Spatial-Physical Indicators	Sense of Place Indicators	Security Indicators	Social Indicators
INT_Rn	1							
Environmental Indicator	−0.249 *	1						
Functional Indicator	−0.082 *	0.123 *	1					
Landscape Indicator	−0.118 *	0.038 *	0.145 *	1				
Spatial-Physical Indicator	0.2 *	−0.641 *	0.227 *	0.073 *	1			
Sense of Place Indicator	−0.22 *	0.473 *	−0.249 *	0.115 *	−0.513 *	1		
Security Indicator	−0.384 *	0.538 *	0.061 *	−0.042 *	−0.528 *	0.408 *	1	
Social Indicator	−0.034	0.366 *	−0.383 *	0.094	−0.26 *	0.368 *	0.018	1

Values with a star are statistically significant at $p < 0.05$.

It was not surprising to see that spaces along the few highly integrated routes were perceived to be desirable, accessible, and convenient. On the other hand, these spaces were also perceived to have higher levels of ASB, such as vandalism, littering, unkempt amenities and street furniture, as well as broken glass and the signs of slogans. The sense of identity and familiarity with the space and with neighbors have also decreased in areas with high integration values. The space syntax measure of integration, however, was not able to explain the social indicator, which is defined in this research by perceived levels of social control and social control. As seen in Figure 3, higher values for the social indicator are scattered in different parts of the historical district.

5. Conclusions

The main objective of this research was to demonstrate the impact of the physical modifications that were implemented in a historical city on its street network connectedness, using space syntax techniques. The research also assessed how long-term residents perceived ASB in different parts of their city. Shiraz, home to two UNESCO world heritage sites, has undergone major changes in the 1950s to provide improvements to the region. However, this research demonstrated that not only have these changes caused disruption to the historical, cultural, and social fabric of the historical district of the city, but they have also introduced opportunities to conduct anti-social behavior (ASB), as perceived by its long-term residents. These public disorder events were perceived to be located along the "few" integrated routes that were the result of improperly planned physical modifications. While space syntax research may no longer be considered a novel approach, pushing the boundaries of space syntax techniques further is critical for the decision-making and implementation processes in urban design and planning for any city. The different measures that were used in this study can help advance future development projects and aid planners in understanding the impact of their decisions on the city's physical and social structure.

Many of the noted problems reported by long-time residents were concentrated along street segments that are characterized as integrated, yet they were disconnected from the rest of the city. As is consistent with previous research [25], these fragmented street segments created fewer opportunities to socialize and offered more opportunities to commit

vandalism, dump garbage, and commit other types of ASB. Whether ASB is harmful or not to residents, within the culture of Shiraz, ASB has an impact on their well-being and quality of life by giving them fewer opportunities to socialize than they once had. In other words, it has become a challenge to see healthy interaction between the inhabitants and their living environment, which has led to perceived social harm and behavioral disorders.

While examining the location of the historical district, it can be observed that it is spatially connected to the rest of the city through a major street that cuts across the city and allows for significant traffic flow through the historical district. While it may seem desirable to provide a street network in this current form, unfortunately, these streets were formed without any spatial logic. In the case of Shiraz, these unplanned changes disrupted the spatial configuration. Although once connected within the fabric of the city, these precious cultural-historical landmarks no longer enjoy natural access making it easy for the inhabitants to visit them, as they frequently did in the past. As demonstrated in this research, for several centuries, the historical landmarks in Shiraz, such as the bazaar, the mosque, and the bath have traditionally been linked up and connected via rings of passageways [75]. Along these integrated routes, people used to celebrate life together through a naturally occurring co-presence. What Jacobs referred to as "eyes on the street", which once occupied these spaces and provided the type of defensible space that Newman called for, are now interrupted by major streets cutting off proper access to these rings, leading to a decline in the quality of life. Another distinction worth noting here was that houses in Shiraz were originally constructed and formed in such a way as to give a sense of privacy, to meet the residents' needs. The estate layout concept, as defined by Frederich, Hillier, and Chiaradia [13], resembles the original pattern of the historical district. However, the later intent to impose a street-based concept during the urban transformation caused further segregation in the inner parts of the city.

Consistent with the findings of Frederich, Hillier, and Chiaradia [13], the perceived levels of ASB incidents were concentrated along highly integrated routes. Although the main axis of the city has become highly integrated over time, the number of segregated streets has significantly increased. The perception of public disorder along these highly integrated routes is sufficient to imply that these streets have provided opportunities for ASB. Shiraz dates to the 6th century BCE, and many of the historical landmarks that are located within the historical district have formed the basis of a spatial configuration, where the connection between these spaces was once more important than connecting streets to each other.

Contrary to our expectations and to earlier research on space syntax and crime and ASB, highly integrated lines should have created a sense of co-presence by bringing people together. However, because of how disrupted these street segments have become and the lack of social logic in the space, the integrated lines were perceived to host ASB. In other words, the creation of a highly integrated axis that breaks traditionally connected street segments has contributed to the perception of high levels of ASB along these highly integrated routes. In his review of intelligible communities, Peponis [69] attributed this to low-intelligibility environments.

The findings of this study suggest that the spatial logic of space is an important ingredient for planners to consider in future changes. A hierarchy of relationships that facilitates transitioning from major streets into local neighborhoods is essential in creating a sense of co-presence, promoting social cohesion among residents, and offering them the opportunity to maintain constant eyes on the streets to ensure their safety. Using space syntax techniques in this research served as a reliable tool that explained why residents perceived ASB to occur around the area of their residences. In summary, to sustain the integrity of our communities and neighborhood, the findings of this study would be valuable for policymakers and planners to assess the impact of any proposed modifications on expected behavior.

This study has some limitations. First, although the respondents were long-term residents and had lived in the historical district of Shiraz for many years, the sample size

was small. Future studies may expand on the sample size through planned town hall meetings or by incentivizing the participants. Semi-structured interviews will also help shed more light on the residents' interpretation of ASB in the historical district, as well as in other parts of the city that comprise the city limits of Shiraz. Further data collection could also include geocoding the officially reported incidents of ASB and sociodemographic variables, as well as environmental Gestalt variables.

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