Article

The Legibility Efficacy of Historical Neighborhoods in Creating a Cognitive Map for Citizens

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Abstract: Nowadays, historical neighborhoods in Iran are in a state of decay due to the lack of spatial legibility with respect to their organic spatial layout. Hence, the level of interaction among people and their perception of the environment has gradually diminished. Historical neighborhoods no longer possess their former prosperity and function, and citizens prefer to inhabit neighborhoods with newer configurations to meet their demands. The aim of this study was to investigate the role of the spatial legibility of historical neighborhoods in creating a suitable cognitive map for citizens. Quantitative and qualitative methods were applied using a questionnaire and simulation test instruments. In addition, in order to analyze the spatial configuration of the target areas, the Space Syntax method was implemented using Depthmap 10. The findings indicated that landmarks and navigation signs were identified as the most important factors affecting legibility from the viewpoint of users. Furthermore, the correlation between integration and connectivity illustrated that the studied areas possessed poor spatial legibility due to the organic texture of their spatial configurations. Accordingly, solutions such as enhancing the interaction between highly integrated streets and identified landmarks were emphasized to ameliorate the legibility of these spaces. The present study contributes to sustainable urban design with respect to the rejuvenation of historical districts by proposing a set of pragmatic alterations of urban spatial configurations. This research may be fruitful for urban designers, planners and managers seeking to revitalize historical neighborhoods.

Keywords: cognitive map; historical neighborhood; intelligibility; landmark; legibility; mental image; permeability; space syntax; spatial configuration; sustainable development

1. Introduction

According to their perceptions and experiences, users of urban spaces acquire some sort of psychological perception of such spaces [1]. In other words, different people create different mental images of the world around them [2]. These images comprise different experiences owing to the fact that they do not replicate the same reality, and individual differences are associated with mental imagery capabilities [3]. In an urban space, a cognitive map of a city is also associated with sensory influences [4], personal and ethnic differences [5–7], collective experiences [8], aesthetic perceptions, and cultural values [9]. In this regard, mental imagery and cognitive maps are an important topic in the field of contemporary urban design and planning, and have recently become one of the main axes of urban landscaping [10]. Examining each of the procedures regarding the extraction of people's mental maps represents an attempt to use such methods in a comprehensive manner [11].

Urban landmarks and symbols should also have the characteristics that make a city legible to citizens, improve their level of visual knowledge and instill a favorable sense of presence in urban spaces [12]. In this respect, landmarks can be defined as prominent urban elements that make the urban fabric more legible and facilitate navigation [13].

Multiple studies have validated the overall correlation between landmarks and the creation of cognitive maps [10,13–15]. Accordingly, citizens feel a sense of belonging to their city, and believe themselves to be obliged in participating in the preservation and maintenance of urban spaces, including their beautification [16]. Cognitive maps can sometimes originate from the senses of touch, taste and hearing [17,18]. Numerous studies revealed that cognitive knowledge is more coherent in a structure that is relatively easy to understand [19–23]. A mental image or cognitive map covers all of an individual's experiences of a given phenomenon and becomes part of his/her subconscious [24]. In other words, it can be said that a cognitive map is a reflection of life in the mind of a person, of which a certain aspect can be selected at any time and explored [25].

Accordingly, spatial cognition plays an undeniable role in the activities which characterize behavioral patterns [26]. This trend can be very effective in reviving the intrinsic motivation of citizens and making the surrounding environment more legible [27–30]. In this respect, legibility can be defined as the possibility of organizing an environment into an imaginable and coherent pattern [31]. These valuable points, as well as other landmarks, should be emphasized in terms of activity and events, so that in the minds of users, urban spaces consistently act as reference points [32–34]. According to these concepts, the performance and efficiency of settlements can be measured by the amount of spatial valuation and the cognitive maps formed in the minds of users [35]. Since the values that enter this process are not physically compatible with each other, mental characteristics must also be considered when examining these concepts [36]. Although legibility is by no means the only attribute of a beautiful city, it becomes significant when we consider the human living environment, i.e., the size and complexity of a city. In this respect, we must not consider a city alone, but must observe it from the perspective of its inhabitants [37].

In this regard, historical textures consist of initial urban development, located in the old parts of cities [38]. Due to their historical structure and socio-cultural significance, historical textures are allotted importance in the process of urban sustainable development [38]. Previous literature supports the fact that residents in traditional textures are profoundly attached to their neighborhoods [39]. More recent studies highlighted the fact that traditional neighborhood design promotes a level of human cognition which makes it possible to perceive the built environment in a more convenient way [40]. Accordingly, the concept of imageability has been developed in order to correlate the association between traditional neighborhood patterns and human cognition [37]. Scholars have argued that a particular physical elements and their arrangement have the ability to draw attention, stimulate emotions and create a perennial impression which may eventually lead to place-making [41]. Indeed, elements of historical neighborhoods such as vernacular architecture, narrow streets, elaborate facades and even bilateral symmetry have a considerable impact on imageability [40].

Nowadays, the notion of sustainable development in some contemporary cities in Iran is restricted in modern districts. According to field studies conducted in Lahijan city, northern Iran, the level of interaction among people and their perception of the environment are at very low levels due to weaknesses in objective and subjective characteristics. This factor has ultimately led to a significant diminution in vitality and security in these spaces. In this process, such neighborhoods no longer have their former prosperity and purpose, and citizens prefer neighborhoods with newer configuration structures to meet their needs. However, the identity of such neighborhoods depends on their antiquity and whether the continuation of such a process will lead to the destruction of such contexts, i.e., whether their historical values have a significant potential to create a sense of belonging among citizens. Accordingly, one of the most important reasons behind the decline of historical neighborhoods is the lack of proper legibility in such neighborhoods. As such, the identity patterns of such neighborhoods are forgotten as time goes on. On the one hand, forgetting the identity patterns, and on the other hand, the organic and unplanned texture of such spaces, leads to the loss of a sense of vitality in such neighborhoods. The purpose of this

study was to investigate the spatial legibility efficacy of historical neighborhoods in creating a suitable cognitive map for citizens. Accordingly, the following questions were posed:

- Is there a significant correlation between spatial legibility and creating a cognitive map for citizens in historical neighborhoods of Lahijan city?
- What is the level of legibility of the studied areas according to their spatial configuration?
- What are the most important criteria and sub-criteria for legibility and the formation of a suitable cognitive map in urban spaces from the perspective of Lahijan inhabitants?

In this study, spatial legibility was found to have a direct and significant correlation with the ability to create a cognitive map for citizens in historical neighborhoods. It was also conjectured that objective factors, such as the structure of spatial configuration in these areas, have a low level of legibility due to their organic texture. Moreover, according to studies, it seems that factors such as *landmarks* and *proper accessibility* can be considered as the most important criteria affecting legibility. The effect of subjective factors such as the patterns and identity signs of neighborhoods, which are unfortunately being forgotten due to their worn texture, has also led to a decrease in the interaction between people and the environment. The present paper contributes to sustainable urban design with regard to the rejuvenation of historical districts by offering a set of pragmatic actions within urban spatial configuration, in addition to generating comprehensive insight towards enhanced spatial legibility and prosperity in historic neighborhoods. The implications of this research can be useful for designers, planners and urban managers in order to revitalize historical sites.

2. Literature Review

Numerous studies on the effect of spatial legibility on the creation of mental images or cognitive maps have been published, some of which were reviewed in this article in order to discern the existing scientific gap in both theoretical and practical aspects. Koseoglu and Onder [31] highlighted that subjective and objective aspects of spatial legibility depend on two main factors, namely the complexity of the urban layout and the saliency of landmarks which can be summarized as two-dimensional and three-dimensional spatial information. Previous studies validated that a Space Syntax analysis can be used as a reliable method for quantitative manipulation in the spatial configuration of urban areas in order to assess the objective facets of spatial legibility [42].

Moreover, the research outcomes of psychological and cognitive approaches in urban space indicate that imageability and spatial legibility contribute as facilitating factors of transforming *space* to *place* [43]. Studies have also indicated that the concept of environmental legibility, alongside individual differences, can affect wayfinding performance, help to obtain spatial knowledge, and improve spatial awareness in urban spaces [44]. Other studies also confirmed the fact that a balanced approach should be taken towards the use of physical exploration and simulation methods, and planners may benefit from the opportunities offered by each method [45]. In this regard, the acquisition process of individual differences and configurational attributes using a questionnaire and simulation analysis of Space Syntax is valuable in providing a comprehensive outlook towards the objectives of the present study.

In previous contextualized studies, Safari et al. [46] identified that the use of regular geometry in the spatial configuration of city centers has a significant correlation with the legibility of that particular space. In addition, a number of studies revealed that spatial legibility can increase the level of social interactions among citizens in urban parks [47]. A simulation study in a hypothetical urban environment revealed that people who remember the exact location of certain landmarks are able to navigate routes with more ease and precision [10].

Findings obtained from cognitive studies in urban spaces revealed that the most important factors in shaping cognitive maps of children consist of parks, playgrounds, green spaces and entrances [48]. Studies also indicated that the integration of urban

legibility elements should enhance the level of navigation, livability, and sustainability in urban spaces [49].

The results of an experimental study indicated that users who used a GPS device had a lower perception of their cognitive maps and the group that sought the relevant path through their direct experience had a higher ability to draw their own cognitive maps [50]. The findings obtained from computational studies in historic districts of China indicated that spatial syntax methodology assists urban designers to understand where the spatial cognition of tourists takes place [51,52]. In a computational study regarding the spatial legibility and morphology of smart cities, Boeing [53] suggested that the morphological growth of cities should be based on the regular orientation of street networking in order to improve spatial legibility. Liao et al. [54] identified that the spatial pattern of historic Chinese towns and cities consists of axiality and concentric approaches which seems to have originated from traditional culture and ideologies. Further empirical studies declared that spatial arrangements have a significant influence on spatial cognition and the way that visitors perceive public spaces [55].

A review of previous studies indicated that despite an array of approaches towards the sustainable development of historical textures, very limited studies focused on the role of spatial legibility on the creation of cognitive maps in order to revitalize such districts. As a result, one of the primary contributions developed in this study relies on scrutinizing the interrelation between legibility and cognitive maps in the context of a *worn* and *organic* structure and configuration in order to enhance the level of interaction between people and their perception of the environment. Moreover, the incorporation of such empirical studies using questionnaires and space syntax, along with the provision of SWOT-based strategies associated with the studied worn contexts, provides a comprehensive outlook for the research. Thus, the present study sought to bridge the identified scientific gap in its contribution to the existing literature towards sustainable development.

Legibility and Its Role on the Creation of Cognitive Maps in Urban Spaces

Studies indicate that legibility in urban spaces is based on the following two main factors: physical and semantic [31]. Physical factors are based on a two-dimensional spatial configuration structure, and perceptual factors (such as landmarks or urban signs) that have a three-dimensional essence [46]. Scholars in this field have long believed that the spatial configuration structure can be analyzed using quantitative methods such as Space Syntax [56,57]. According to this method, the spatial configuration of cities has a significant correlation with the movement and behavioral patterns of the people within that city [58]. These studies also revealed that axial line maps are directly related to the perception of space and thus, the ability to create a cognitive map in the minds of people in urban spaces [59].

In 2001, researchers at the Bartlett School of Architecture formulated software for the analysis of urban spaces in a further attempt to quantify this theory. This software analyzed the visibility graph analysis in the built environment in addition to measuring the axial lines [60]. In this regard, integration and connectivity were identified as two fundamental variables playing an influential role in this process [61]. Accordingly, the higher the degree of integration, the more that space is used; a higher range of connectivity can also be indicative of better accessibility within that space [57,62]. Furthermore, numerous studies demonstrate that the correlation between integration and connectivity results in spatial intelligibility; therefore, the higher the degree of correlation is, the higher the degree of spatial legibility [42,63–66]. Researchers believe that there is a significant correlation between spatial intelligibility and cognitive maps [67].

The theory of spatial legibility and mental imagery was first introduced by Kevin Lynch [37]. In field studies that were conducted in some American cities, he considered five factors that influence the legibility of urban spaces and the formation of cognitive maps. According to his findings, the five factors of district, landmark, path, node and edge are effective factors in the legibility of an urban space [37]. Subsequently, many studies were conducted on the role of landmarks in legibility and wayfinding in urban

spaces [68–71]. At the same time, factors such as landmark saliency [31], visual clarity [72], distinctive colors [48], symmetry, balance and equilibrium [32] and landmarks' distance and orientation [50] can play a significant role in the legibility of urban spaces. Studies also advocate that green gentrification within urban areas is strongly correlated with an improvement in the range of livability and the establishment of social interactions [73,74]. Moreover, the characteristics of the built environment are associated with social interaction, personal relationships, behaviors and activities among community members [75–77]. In addition, permeability, which is defined as the capability of the pedestrian flow to permeate an urban network system, plays a substantial role in the creation of cognitive maps [78,79] and is strongly associated with the visibility graph analysis [56].

On the other hand, in his other study, Kevin Lynch [79] examined the effect of the sense of time on the creation of cognitive maps. According to Lynch, feeling *the present* lead to making a meaningful connection with *the past* and *the future*, and lead to the creation of appropriate cognitive maps [79]. Meanwhile, studies illustrated that socio-cultural factors also have a significant impact on the formation of cognitive maps [80,81]. Findings have suggested that a neighborhood, as an identity setting, can also contribute significantly to promoting a sense of attachment to place [82]. Furthermore, the sense of belonging to a place is based on cognitive, emotional and spiritual aspects that lead to the promotion of identity and social participation among people [83]. This sense, which is derived from the personal characteristics and experiences of the audience, is one of the factors affecting the formation of cognitive maps or mental images for the audience [84]. Factors such as security, safety and social satisfaction are also considered to have an undeniable impact on the formation of users' cognitive maps [85] (Figure 1).
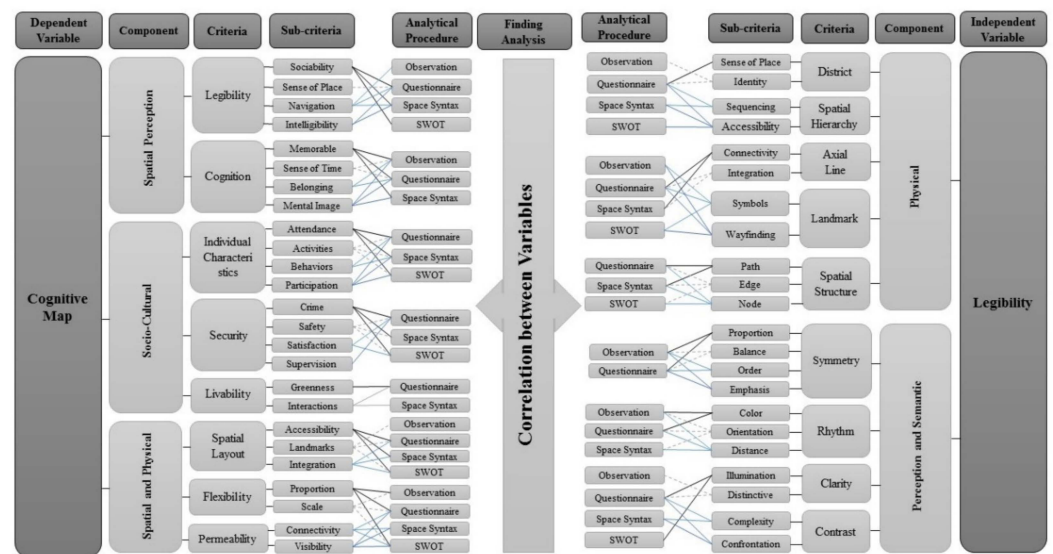

Figure 1. Conceptual framework of the factors affecting legibility and cognitive map creation along with the analytical approach of each component according to the adopted research flow.

3. Research Methodology

The method used in this study was a combined quantitative and qualitative approach. The present study was carried out with a descriptive inferential approach using library resources and field studies. On this basis, after conducting analyses using books and papers on the factors affecting independent and dependent variables, the theoretical framework of the research at hand was developed. The research method comprises various stages that can be measured according to the conceptual framework of the research. Furthermore, the conceptual framework consists of a variety of criteria and sub-criteria related to the adopted procedures. Hence, to develop a better understanding, the role of some of the sub-criteria such as *permeability*, *accessibility*, *visibility*, etc., and to obtain participants' opinions directly,

a syntactical analysis was performed in order to complement the applicability of datasets within the studied contexts.

Accordingly, during the process of field observations, initially, influential areas were investigated in order to distinguish important landmarks as accurately as possible. In the next stage, according to the literature and the explained theoretical framework, a questionnaire was compiled to evaluate the opinions of the residents of the studied neighborhoods. The structure of the questionnaire consisted of the following five stages: demographic data, criteria of cognitive maps, criteria of legibility, sub-criteria of cognitive maps, and sub-criteria of legibility. During this process, the adopted criteria and sub-criteria were the subject of experiments, with the five-choice Likert spectrum used as a basis for the survey structure. Option criteria were ranked according to the following scale: 1—strongly disagree, 2—disagree, 3—agree to some extent, 4—agree, 5—strongly agree. The questionnaire was then sent for revision to a number of urban design specialists to ensure its suitability. Based on their opinions, the definitions of specialized words such as *spatial legibility*, *cognitive map*, etc., were incorporated into the questionnaire in an attempt to mitigate any obscurity or confusion for the participants.

In the first stage, the questionnaire was responded to by 25 participants using the pre-test method. After obtaining the results, the findings were tested by Cronbach's alpha, which showed an alpha value of 0.76 and indicated the appropriate reliability of the questionnaire. In the next step, the Morgan table was used to calculate the sample size. According to this table, in cities with a population of over one hundred thousand people, 384 participants should be considered as a statistical sample population [86]. It should be noted that sample selection bias was considered with respect to the randomization of selecting the population sample in order to avoid any sort of distortion in the process of analysis. In addition, in order to generalize the subject as much as possible, an attempt was made to analyze two different case studies with analogous socio-cultural characteristics. Accordingly, 192 questionnaires were distributed among the participants in each neighborhood indiscriminately so that a comparison could be made on a peer-to-peer basis. The data collection process was conducted in November 2021. It should be noted that no incentives were considered for the participants.

Findings obtained from the questionnaire were analyzed using *Microsoft Excel 2016* (developed by Charles Simonyi in Washington, DC, USA) and *SPSS 16* (developed by Norman Nie et al. in Chicago, IL, USA). SPSS was adopted as a reliable processor in order to assess the distribution trends of data and conduct intricate descriptive and inferential statistical analyses [60]. In the analysis section of the questionnaire, inferential findings were presented after expressing descriptive findings and the frequency of data. One of the prerequisites of conducting an inferential analysis is to understand the normal distribution status of data. To measure the normality of the data, the Kolmogorov–Smirnov test was used as one of the most significant tests [87]. This test determined the parametric or nonparametric nature of the data. Moreover, in order to evaluate the homogeneity and equality of variances, the Levene test was carried out as a prerequisite of inferential analysis [88]. Afterward, due to the parametric nature of the data, the independent *t*-test was used to compare the two main variables in this study. Ultimately, the Pearson correlation test was applied to determine the relationship between the variables.

In the next step, spatial configuration in the studied areas was analyzed using the *Space Syntax*, *axial map* and *visibility graph analysis* methods. A syntactic analysis was performed using the Depthmap 10 software developed by Alasdair Turner in London, UK [60]. This software was designed to analyze urban morphology and evaluate its spaces in order to identify the formation of movement and behavioral patterns through simulation analysis. Regarding its application in this study, it can be acknowledged that by using integration and connectivity variables and obtaining the affiliated correlations between them, spatial legibility can be achieved through the spatial configuration of the studied areas [42,65,89]. Space Syntax specifically related to the movement patterns of people in urban areas, and

this pattern in a physical setting has a significant correlation with the relationship obtained from a spatial configuration analysis [58].

Finally, the strengths, weaknesses, opportunities and threats of the mentioned neighborhoods were examined using the SWOT model. This technique is an efficient qualitative method that can be used to identify the environmental conditions and internal capabilities of projects, and is based on the understanding of the environment from field observation evaluations. Fundamentally, in this process, the strengths and weaknesses depend on internal factors and opportunities, and the threats are influenced by external factors [90]. To achieve a comprehensive and integrated result, all aspects including morphological, physical–spatial, socio–cultural and economic aspects were examined. In this respect, the strengths, weaknesses, opportunities and threats of neighborhoods were examined in order to provide appropriate suggestions to improve spatial legibility. The research flow and the adopted methodological are depicted in Figure 2. It is worth pointing out that the ethical considerations taken into account in this study include the voluntary participation of respondents and avoidance of using offensive, discriminatory language or other unacceptable words in the data collection phase. In addition, respondents' privacy and the highest level of objectivity in discussions and analysis were considered during the research process.
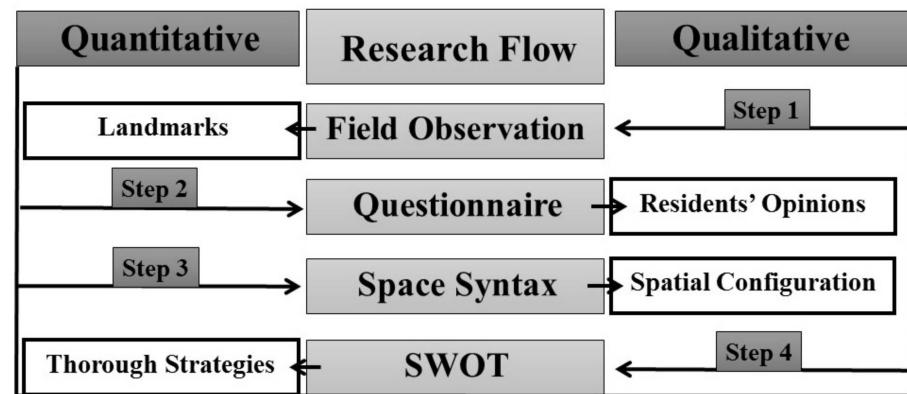

Figure 2. Research flow and adopted steps developed in the present study.

Study Areas

Lahijan city is located in the eastern part of Gilan province, located in northern Iran. It is bounded by the Caspian Sea on the north, the city of Rudbar on the south, the cities of Langrud and Rudsar on the east, and the cities of Astane and Rasht on the west (Figure 3). Based on the conducted population census in 2016, the population of this city is 101,073 people. The configuration of Lahijan city encompasses both traditional and modern textures. This city, which has a semi-organic structure, is located on the northern hillside of the Alborz Mountains. Its culture and favorable climatic conditions make Lahijan a major tourism center in northern Iran. Historically, this city was a large commercial center and the capital of East Gilan during the reign of some rulers. Lahijan also acted as the tourism hub of the Islamic world in different periods of Iran's history. It should be noted that in order to better generalize the subject, two samples of old neighborhoods in Lahijan that encompass an organic texture were studied.

The studied areas in this research were the Gabaneh and Caravansary neighborhoods. These historic neighborhoods were selected due to fame, significance, and identity patterns which are confronted with a lack of suitable imageability for citizens. Gabaneh = is located in the southwest of Lahijan. In the past, this neighborhood functioned as a place where edible vegetables were grown and livestock were reared. Hence, some of the inhabitants believe that the meaning of the neighborhood's name is *agricultural land*. The holy shrines of *Aqa Pir Ali* and *Aqa Mir Ibrahim*, and the *Akbariyeh Mosque* are also located within this area. These sites can be considered as the most important landmarks in the neighborhood. Caravansary is yet another neighborhood featuring an old texture in Lahijan, and it is

located in the southwest of this city. This neighborhood adopted its current name due to its proximity to the most important caravanserai of the city in ancient times. Based on field studies, the key elements in the neighborhoods, along with their images and locations on the map, are listed below (Figure 4).
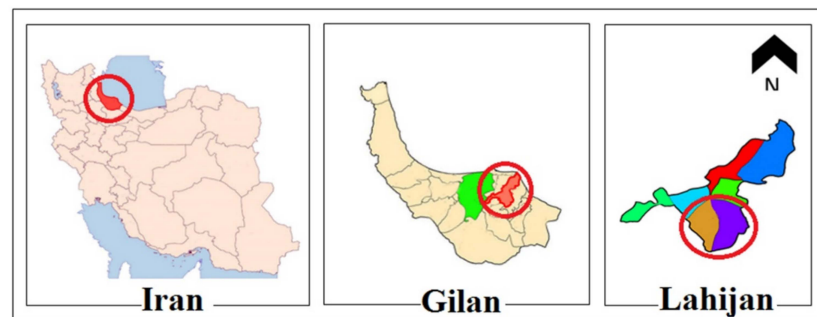
Figure 3. The geographical position of the study area on the map (country: Iran; province: Gilan; City: Lahijan).
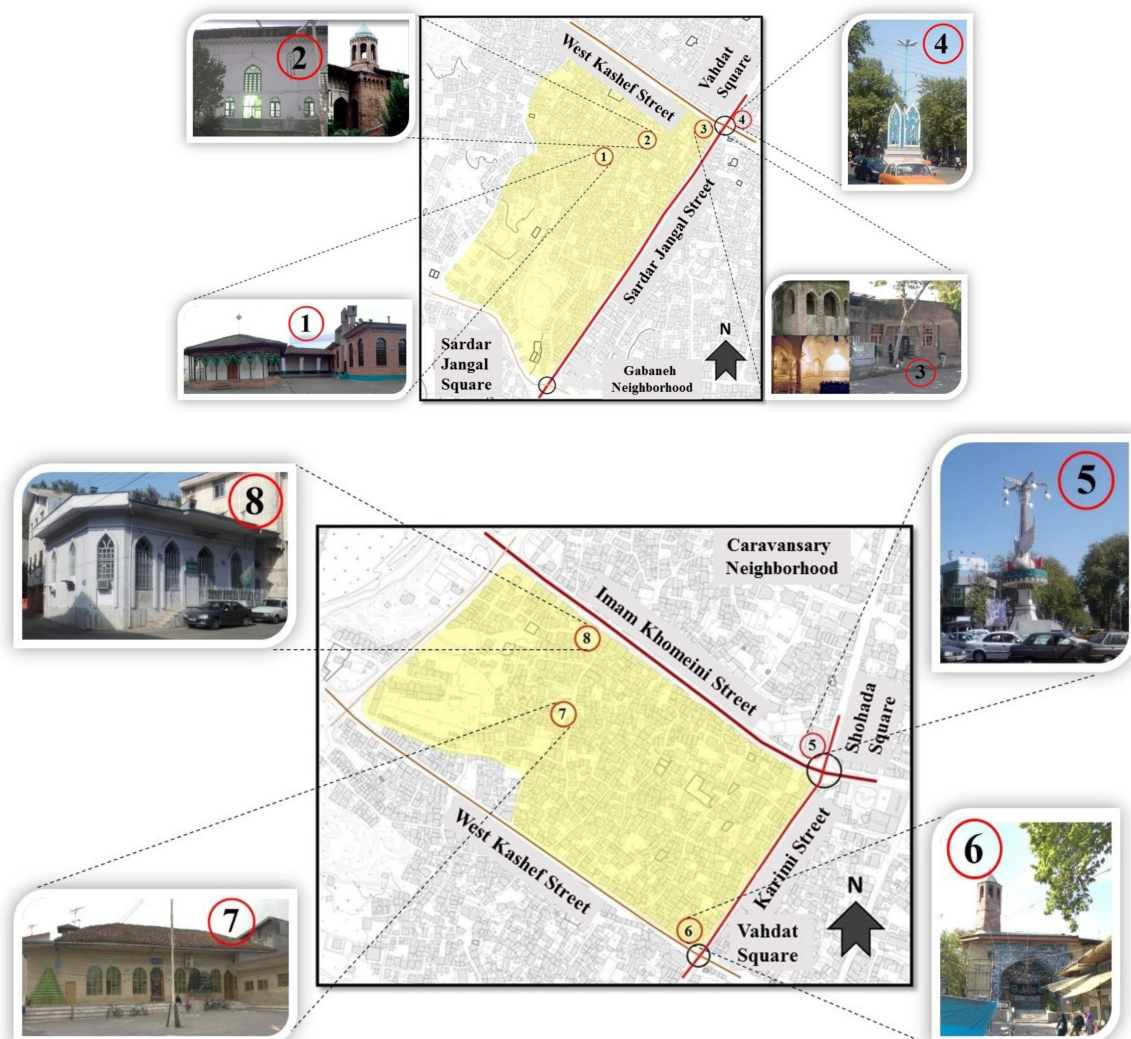

Figure 4. The studied areas and the location of their most important landmarks on the map: 1. The Holy Shrine of Aqa Pir Ali; 2. Akbariyeh Mosque; 3. Golshan Bath; 4. Vahdat Square; 5. Shohada Square; 6. Central Mosque of Lahijan; 7. Valiasr Mosque; 8. Al-Zahra Mosque.

4. Results

After obtaining the desired data from the statistical population, in order to organize and categorize them as well as possible, the data were imported into Excel software for conversion into organized charts. Findings from the demographic characteristics of the statistical population indicate that 59% of the participants were male, and 41% were female. Regarding the age group of the statistical population, it should be noted that 53% of them were in the *youth* age group. Additionally, 35% of the sample population were students or unemployed, 26% were self-employed, 21% were engineers or physicians, 10% were housewives and 8% were employees in other areas. In relation to the duration of their residence, it should be noted that 31% of participants were tourists, 28% of them had been residents for more than 16 years, and 20% of them had been residents for 1 to 5 years in the neighborhoods studied (Figure 5).
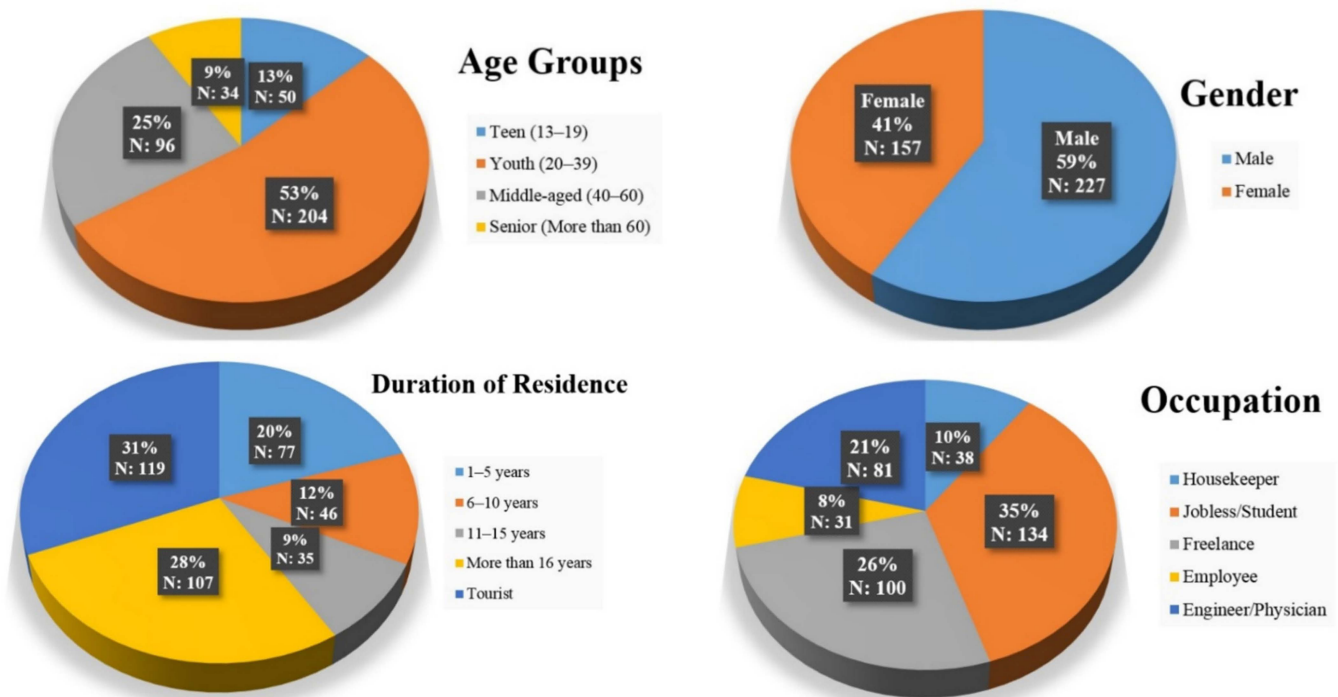

Figure 5. Demographic data of the statistical population obtained from the findings of the questionnaire.

Findings obtained from the questionnaire affecting the legibility of urban space in the study areas indicate that from the users' point of view, *Landmark* was the most important factor for the legibility of urban spaces. Out of a total of 384 questionnaires received, 294 (equivalent to 77%) agreed or strongly agreed with the importance of the role of a Landmark in establishing legible urban spaces. After Landmark, factors such as *Neighborhood Structure*, with 59%, *Spatial Perception*, with 57%, and *Spatial Configuration*, with 55% of agree and strongly agree responses, were identified as the most important factors affecting the legibility of the studied neighborhoods, respectively. It should be noted that the findings related to the criteria affecting legibility were also measured separately in each neighborhood, and the priorities were almost in the same range in both (Figure 6).

Regarding the criteria affecting the ability to create a proper cognitive map in the minds of the audience, the findings revealed that in the Gabaneh neighborhood, *Spatial Cognition* (with 83% (equivalent to 159) of participants responding with agree or strongly agree), was recognized as the most important factor in shaping users' cognitive maps. Afterward, the factors of *Legibility* with 63%, *Permeability* with 56%, *Spatial Layout* with 54% and *Livability* with 42% of agree or strongly agree responses, were identified as the most important factors in the formation of cognitive maps, respectively. Meanwhile, this

issue in the Caravansary neighborhood also revealed the foremost importance of *Legibility* with 144 responses (equivalent to 75% of the total votes) that agreed or strongly agreed. Thus, legibility was considered as the most important factor in this respect. After Legibility, factors such as *Cognition* with 68%, *Spatial Layout* with 60%, *Permeability* with 57% and *Livability* with 46%, were identified as the most important priorities in forming a proper cognitive map in the minds of users (Figure 7).
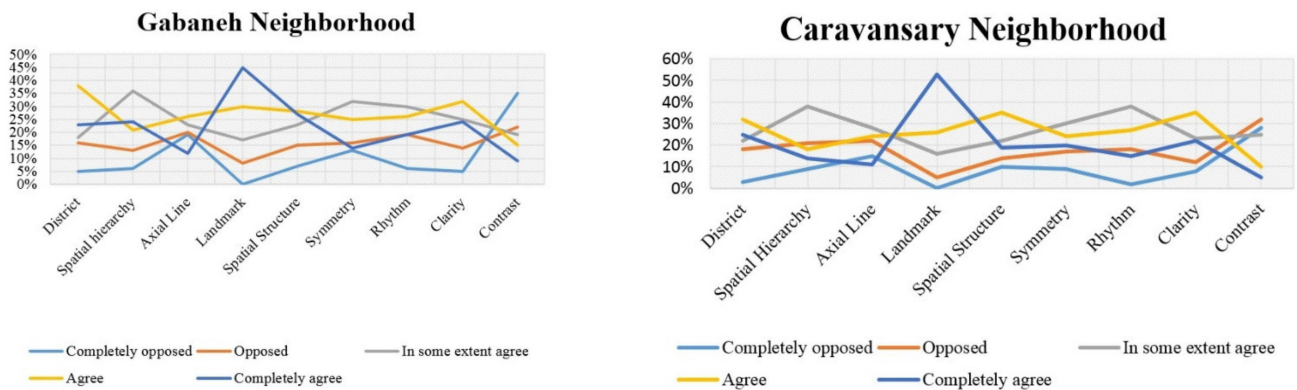
Figure 6. Factors affecting urban legibility in the studied areas from the viewpoint of participants based on the strongly agree to strongly disagree spectrum.
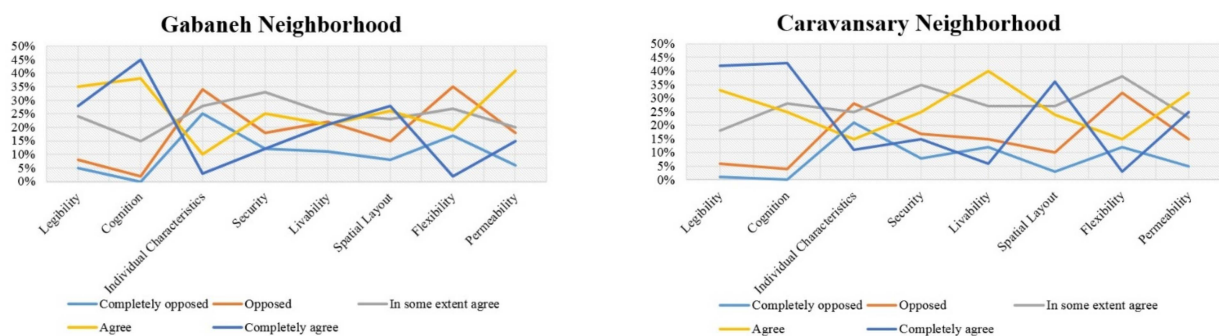
Figure 7. Factors affecting the formation of cognitive maps in the studied areas from the viewpoint of participants based on the strongly agree to strongly disagree spectrum.

In relation to the sub-criteria affecting legibility, it should be noted that *Navigation Boards*, with 76% of the responses indicating agree or strongly agree (equivalent to 292 participants), were recognized as the most important sub-criteria affecting legibility in urban spaces. Afterward, *Visual Clarity*, with 72%, *Good Range of Accessibility* with 65%, *Proper Illumination* with 63%, and the *Use of Symbols* with 60% of the agree and strongly agree votes were recognized as the most important sub-criteria affecting legibility (Figure 8). On the other hand, in relation to the sub-criteria affecting the formation of an appropriate cognitive map, *landmarks* received 75% of the agree and strongly agree votes (equivalent to 288 participants), is recognized as the most important sub-criteria affecting the formation of an appropriate cognitive map from the viewpoint of the statistical community. Afterward, factors such as *Mental Image* with 73%, *Intelligibility* with 72%, *Range of Visibility* with 71% and *Sense of Belonging* with 64% of the agreed and strongly agreed votes were, respectively, considered as the most important sub-criteria affecting the formation of appropriate cognitive maps from the perspective of the statistical community (Figure 9).

In order to complete the process of analyzing the findings obtained from the factors affecting legibility and cognitive maps in the studied areas, the relevant data were compared using SPSS and the independent *t*-test. The first step was to test the normality of the data. The results of the Kolmogorov–Smirnov test indicated that the *p*-value was greater than 0.05, and the data obtained from the two groups had a normal distribution. Therefore, due

to the parametric nature of the data, the independent *t*-test was adopted. The results of the Levin test showed that the significance value was equal to 0.98, which indicates that the variances were equal and homogeneous. Furthermore, the significance of bi-domains was equal to 0.92, which indicates that there was no significant difference between the findings in the two neighborhoods. The Pearson correlation test was also implemented to understand the internal relationship between the variables. Accordingly, the results of the Pearson bi-variable correlation test between the sub-indices affecting legibility and the cognitive map showed that the significance level of correlation between these two variables was 0.00, and since this value was less than 0.05, it can be inferred with a 99% confidence interval that there was a significant correlation between the variables of legibility and the cognitive map. Therefore, the legibility of the physical elements in the studied areas leads to the improvement of the formation of a cognitive map within it and subsequently, the first hypothesis of this research is confirmed.
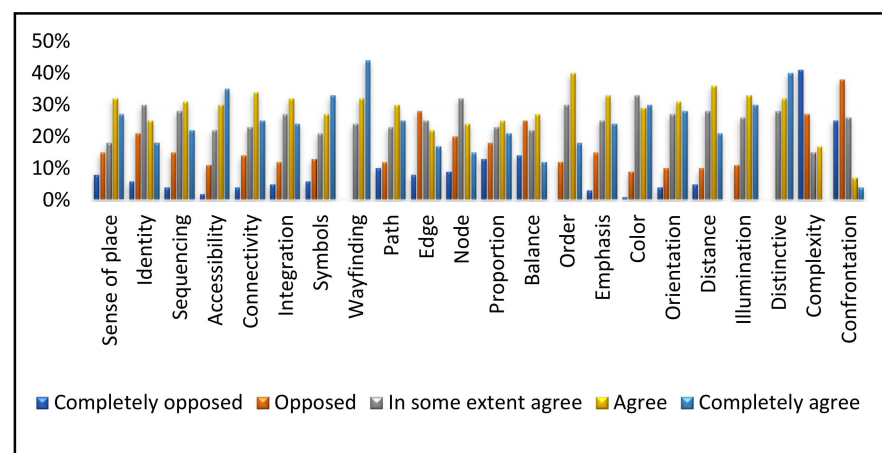

Figure 8. Sub-criteria affecting spatial legibility from the users' point of view.
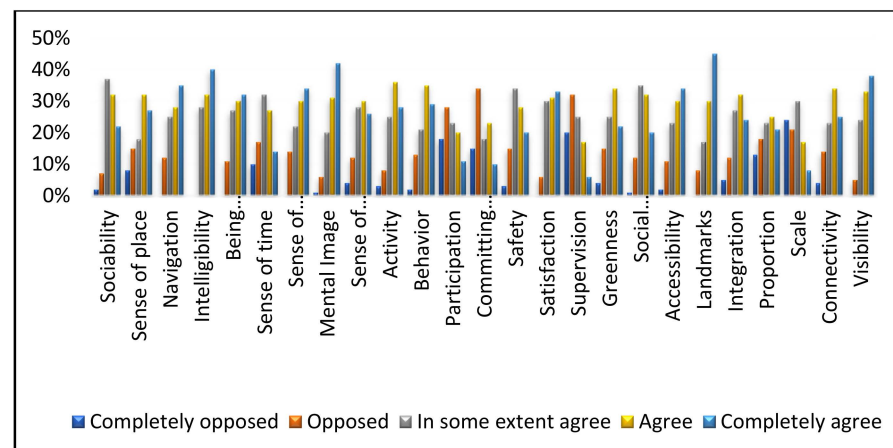

Figure 9. Sub-criteria affecting the formation of cognitive maps from the users' point of view.

The findings obtained from the spatial configuration analysis of the studied neighborhoods using the Space Syntax and axial line map methods illustrate that *West Kashef Street* in the Gabaneh neighborhood had the highest spatial integration rate with a numerical value of 1.74. Meanwhile, the highest level of spatial integration in the Caravansary neighborhood was related to *Karimi Street* with a quantitative value of 1.69. Additionally, the highest level of connectivity in Gabaneh neighborhood was related to *Sardar Jangal Street* with a numerical value of 12. This value indicates the highest level of access to this street. This value in the Caravansary neighborhood is related to *Imam Khomeini Street* with a connectivity level of 9 (Figure 10). Additionally, the findings obtained from the

correlation test between integration and connectivity in Gabaneh neighborhood reveal that the intelligibility in this neighborhood is equal to 0.40, while the correlation test between integration and connectivity in the Caravansary neighborhood is equal to 0.46. This means that according to the spatial configuration structure analysis in the above-mentioned areas, the spatial legibility is very low (Figures 11 and 12). It should be noted that in an optimal case, the value of R^2 is greater than or equal to 0.70; which is significantly different from the obtained results.
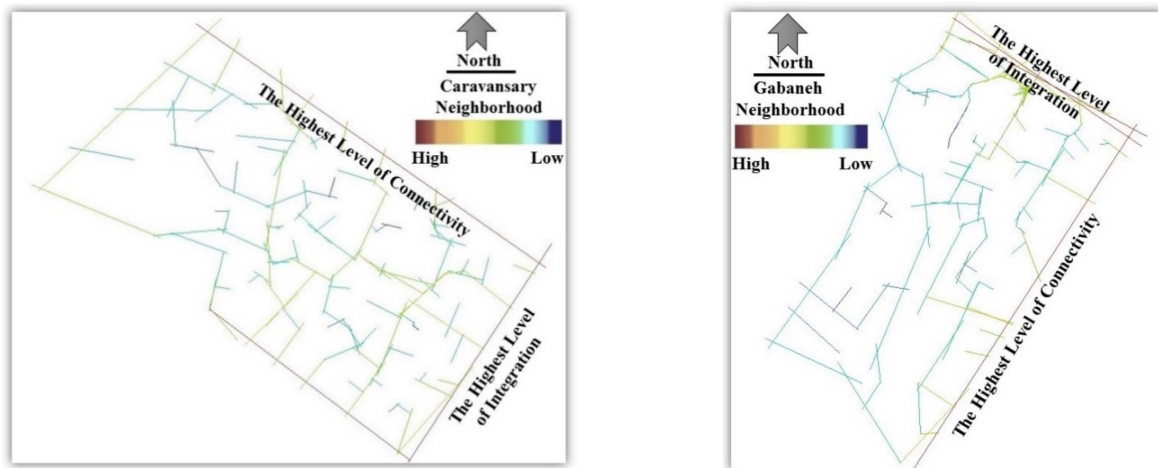

Figure 10. Axial map of integration value in the Gabaneh and Caravansary neighborhoods based on the spatial configuration analysis using Depthmap 10.
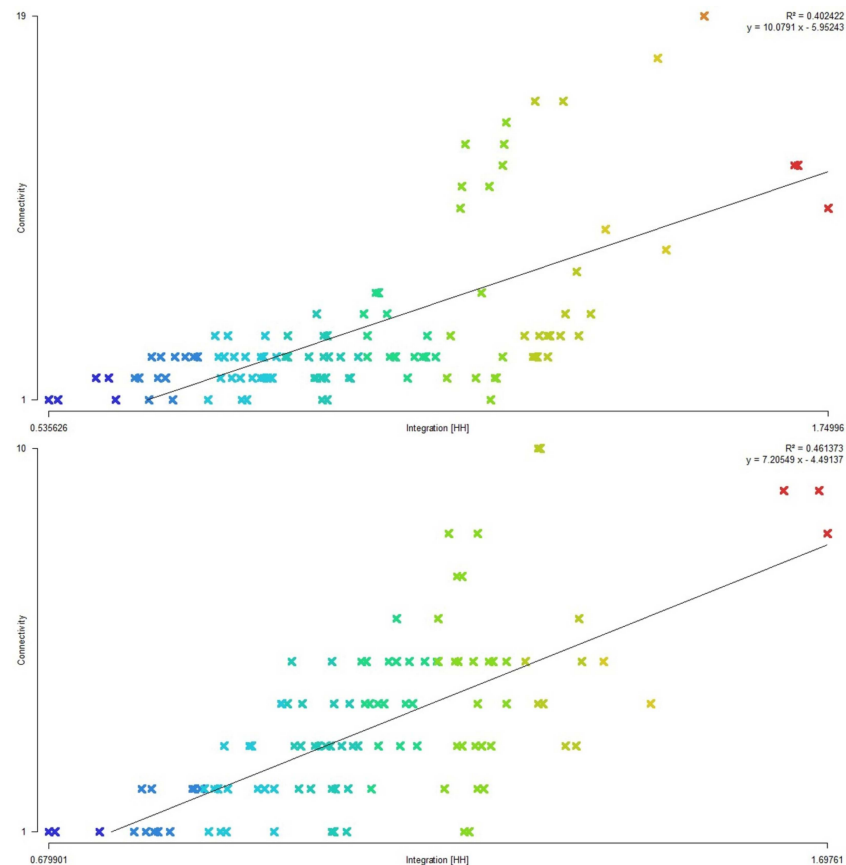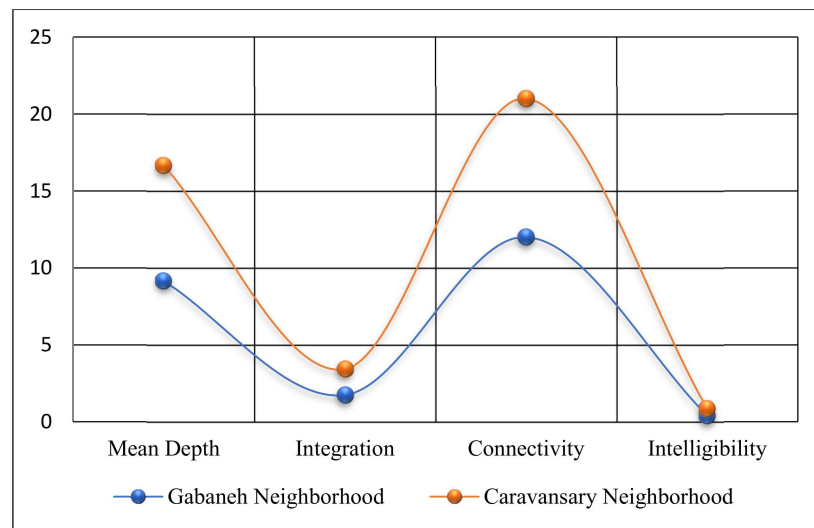

Figure 11. Correlation test between integration and connectivity in Gabaneh and Caravansary neighborhoods as an indicator of spatial intelligibility using Depthmap 10.

Figure 12. The quantitative value comparison of the effective components of legibility in the studied areas based on the spatial configuration analysis.

In the next step of the syntactical analysis, a visibility graph analysis was performed in both studied cases. Accordingly, by incorporating the obtained results from step 1 and step 3 of the research flow (Figure 2), an attempt was made to reinforce the streets and alleys which lead to the identified landmarks of the neighborhoods. This process increases the level of permeability within the contexts in order to promote the saliency of the landmarks. On this basis, the spatial configuration analysis in the Gabaneh neighborhood unveiled three major subsidiary alleys that require restructuring and reinforcement in order to ensure a constructive interaction between the quality of spatial configuration and the significant landmarks of the city. On the other hand, the performed analytical procedures in the Caravansary neighborhood illustrated that a small number of identified landmarks are located in the vicinity of highly integrated and highly connected streets, while the others are latent in the central core of the neighborhood. Accordingly, it is important to ensure that the identified street leading to the landmarks is optimally reinforced in order to augment the permeability as well as legibility of the neighborhood. Doing so would increase the ability to create suitable cognitive maps in the mind of users that may stimulate their sense of attachment to their neighborhood (Figure 13).

Figure 13. Identification of the most important streets that have to be reinforced in order to enhance the permeability within the neighborhoods and provide an influential interaction between 2D configurational attributes and 3D landmarks using incorporation of step 1 and step 3 of the research flow.

In the next step, according to the findings obtained from the questionnaire and syntactical analysis, a set of empirical observations were conducted in order to collect data in terms of analyzing the strengths, weaknesses, opportunities and threats in the studied neighborhoods (Table 1). Thus, in the initial step, the SWOT analysis was performed based on morphological characteristics. In this regard, the strengths of the morphological categories include *the existence of some religious and historical monuments* that may have influential roles as *landmarks* to facilitate the legibility of the neighborhoods. In the next step of the SWOT analysis, physical and spatial features of the studied areas were investigated in order to assess the impact of internal and external factors in the historical sites. As a result, by exploring social, cultural, and economic factors with an influential role in the creation of cognitive maps, based on the conducted conceptual framework, a comprehensive approach in the analysis process was achieved. It should be noted that the SWOT matrix was used as an exclusively analytical instrument developed in this study in the absence of urban policy processes.

Table 1. Analysis of the strengths, weaknesses, opportunities and threats in the neighborhood based on research findings and field observations using the SWOT technique.

Category	Internal Factors	External Factors	Internal Factors	External Factors
	Strengths	**Weaknesses**	**Opportunities**	**Threats**
Morphology	1. Existence of religious and historical places in the neighborhoods. 2. Proximity of the neighborhoods with the main streets of the city, which facilitates accessibility to all parts of the city. 3. Proximity of the northeastern side of the neighborhood with the traditional bazaar of Lahijan.	1. Difficult access between neighborhood blocks due to their small size and their organic texture. 2. Interference of religious and ritual places with residential land uses. 3. Existence of commercial localities in residential blocks. 4. Abandonment of some residential blocks in terms of their stability and facade revitalization.	1. Existence of valuable historical edifices which can increase the number of tourists. 2. Existence of pleasant organic paths which promote the sense of belonging of residents and tourist attractions. 3. Performance of religious rituals on special days of the year in several parts of the neighborhood. With proper planning, these events can be promoted as an indicator of tourist attraction.	1. Continuation of the influence of commercial uses in the residential context of the neighborhoods. 2. Lack of visual coordination between the new constructions and historical buildings. 3. Changing the pattern of the street, the edges and the skyline pose a threat to the configuration and structure of the neighborhood.
Physical—Spatial	1. Active connection of the neighborhood with prominent urban landmarks. 2. Regular configuration on the main axis of the streets. 3. Maintenance of the defined edges of the main streets using analogous trees.	1. The dissociation of the Gabaneh neighborhood through Kashef Street. 2. Lack of confinement of neighborhood squares. 3. Lack of definition of a proper edge in Shohada and Vahdat Squares.	1. Possibility of turning ruins and unbuilt lands in the texture into vibrant urban spaces. 2. Possibility of strengthening neighborhoods through promoting landmarks. 3. Possibility of strengthening the organic texture and creating a suitable atmosphere for tourists.	1. Lack of conservation regarding the organic texture as a valuable heritage, and their increased destruction. 2. Ignoring the organic pattern of subsidiary pathways. 3. Destruction of significant monuments.

Table 1. *Cont.*

Category	Internal Factors	External Factors	Internal Factors	External Factors
	Strengths	Weaknesses	Opportunities	Threats
Physical—Spatial	4. Existence of significant monuments and identity elements in the texture.	4. Exhaustion in some parts of the neighborhood. 5. Non-compliance of the old textures with new constructions.	4. Possibility of creating a tourism passageway in order to display the historical monuments.	4. Lack of attention to the center of the neighborhood as a valuable milieu for creating a sociable public space
Social—Cultural—Economic	1. Trans-regional nature of many economic activities in the city. 2. The presence of the bazaar, and its importance in the economic prosperity of the city. 3. The presence of old houses, which indicates the originality and identity of the neighborhood. 4. Holding religious ceremonies and upholding customs. 5. Existence of prominent religious monuments as landmarks.	1. Existence of maladjusted retail businesses. 2. Failure to take advantage of the economic opportunities in the tourism industry, bearing in mind the high cultural and historical potential of the area. 3. Emergence of crime in dead-end alleys, and stagnation of barren lands. 4. Inadequate infrastructure to establish the required facilities for the youth. 5. Lack of social vitality in the neighborhoods.	1. Possibility of recreating the structure of the neighborhood and the bazaar in order to revitalize the neighborhood spaces. 2. Possibility of revitalizing local handicrafts and indigenous occupations. 3. Possibility of ameliorating neighborhood centers to increase public participation due to the existence of mosques. 4. Opportunity to attract tourists in the context by strengthening the key elements in the neighborhood and old buildings.	1. Low economic return of the construction compared to the northern part of the city. 2. The emergence of sizeable shopping malls and the shift of the city's commercial center from the markets in the old texture to the new texture of the city. 3. Risk of an increase in social anomalies due to the presence of useless lands and abandoned houses. 4. Lack of attention to old buildings fades away the identity role of the neighborhood.

5. Discussion

In relation to the undeniable role of landmarks and signs in the legibility of urban spaces, the findings of this research are in agreement with those of previous studies in this field [10,50,69–71,91]. However, the use of navigation boards as one of the most important factors affecting legibility is another finding that emerged in the present study from the perspective of the statistical community, which, despite its significance and easy assessment, is usually neglected in research projects. As such, their importance revealed one of the novel outcomes of the present study. Another outcome of the present study is the perceived weakness of the studied areas in terms of spatial configuration. This is due to the organic nature of the urban context in these spaces, which greatly diminishes spatial legibility. This issue was identified in previously conducted studies [92–95].

Accordingly, the need for adequate organization of the context in the studied areas has gained relevance. Therefore, emphasizing the edges and axis of the streets, and

enclosing nodes as well as urban squares, can help to increase the legibility of these spaces. Meanwhile, by identifying the most promising signs and urban landmarks which characterize historical and socio-cultural values, it would be possible to revitalize the sense of place. Moreover, by maintaining, restoring, and emphasizing them in the urban structure, in addition to retrieving the historical identity of the neighborhoods [96], it would be possible to ameliorate spatial legibility and sustain wayfinding within these spaces. In addition, the existence of a multitude of religious buildings in these neighborhoods, which are considered as a center for holding religious ceremonies and rituals and expressing the identity of the Islamic Iranian city, should be taken into consideration when promoting it.

On the other hand, an urban morphological analysis indicated that the streets of *West Kashef* and *Sardar Jangal* in the Gabaneh neighborhood, and *Karimi* and *Imam Khomeini* in the Caravansary neighborhood characterized the highest values of spatial integration. In this regard, the ease of accessibility of the above-mentioned streets to the identified landmarks should be taken into consideration in order to improve the legibility of these spaces as well as the tourist reception capacity in these areas. The application of this theory was novel and the importance of the interaction between high-integrated spatial configuration and prominent landmarks in urban spaces can be considered as yet another original finding, while only the association between the geometry and the saliency of landmarks was highlighted in previously conducted studies [31,97,98]. In addition, the possibility of improving the permeability level of the spatial configuration within the central core of the space leading to identified landmarks in order to enhance the creation of suitable cognitive maps for citizens was emphasized as yet another important factor.

One of the main attributes of the studied contexts is the focal role of traditional bazaars in the creation of socio-economic functions of citizens. Historically, the traditional bazaar of Lahijan, in addition to acting as the main hub of marketing over this city, was considered as one of the major tourist attractions in the city. One of the special features of this bazaar is that it directly affects the sensory experiences of users, including the senses of sight, hearing, smell, touch, and taste. Previous literature corroborated that a built environment which stimulates the human senses can have a positive effect on the formation of cognitive maps [4,17]. In fact, the emergence of shopping malls in modern context of the city detracted from the former prosperity in this traditional bazaar. Accordingly, fostering and promoting the traditional bazaars of this city must be prioritized in order to reconstruct forgotten cognitive maps across these historical contexts.

Moreover, adequate lighting in narrow alleys that have an organic and worn texture can help prevent crime and subsequently, improve spatial legibility and economic prosperity—a finding aligned with those of previous studies [99–102]. Meanwhile, the appropriate cultural-economic use of vacant land, such as the establishment of the *Tea Museum* as one of the main tourism hubs of Lahijan city, has an undeniable influence on the vitality and sustainability of these neighborhoods. The construction of booths, with the aim of fostering the handicrafts and vernacular products of the region, can also help create more intelligible cognitive maps and mental images for tourists and visitors of these historical contexts. Thus, the aforementioned guidelines should be considered in future projects by urban managers in order to revitalize the lost prosperity of historical neighborhoods.

6. Conclusions

The main objective of this study was to determine the effect caused by the legibility of physical elements in the city on the creation of a suitable cognitive map for citizens in the historical neighborhoods of Lahijan. Urban landmarks should have the capacity to render the city legible for citizens, in addition to enhancing their level of visual knowledge and providing them with a positive presence in urban spaces. It is in this way that people feel a sense of belonging to their city, and consider themselves obliged to participate in its preservation and maintenance. A cognitive map encompasses all the experiences an individual may have of a certain phenomenon, either good or bad, and becomes part of the human subconscious. It can also be stated that a cognitive map is a reflection of

people's lives in their minds, from which they can select and extract a certain element at any given time based on their requirements. Accordingly, the study of the influence of legibility of physical elements in the city on the creation of citizens' cognitive maps is considered incumbent and undeniable, which can help improve the sustainability of historical neighborhoods.

The findings of the questionnaire indicate that urban landmarks are considered as the most important factor for the legibility of urban spaces from the perspective of the statistical community. On the other hand, the most important factors affecting the creation of a proper cognitive map were considered to be *spatial cognition* and *spatial legibility*. In relation to the sub-criteria affecting legibility, *navigation boards* and *significant monuments* that play a role in the visual signs in urban space were identified as the most important factors affecting legibility and the creation of suitable cognitive maps in the minds of users. Subsequently, the results of the correlation analysis revealed a significant relationship between legibility and the creation of a suitable cognitive map. In addition, the findings obtained from the spatial configuration analysis indicated that the values of legibility in the studied neighborhoods were very low, and this factor may represent the most important reason behind the deterioration of old neighborhoods that embrace historical value.

Overall, the findings of this study indicate that the legibility of the studied neighborhoods in Lahijan city has a significant correlation with the ability to create a cognitive map among the inhabitants of those neighborhoods. Additionally, due to the organic nature of the traditional texture of these neighborhoods, which lessened the integrity of the spatial configuration, the revitalization of these neighborhoods with an emphasis on the definition of axial edges should be taken into consideration. On the other hand, the interaction between the spatial configuration structure and urban landmarks, and the application of the strategies discussed can lead to an increase in legibility, and a more desirable formation of proper cognitive maps of these neighborhoods. In future research, the role of urban landmarks in wayfinding can be studied using simulation methods and by tracing observations. In addition, such empirical studies can invite strangers and tourists to participate as the target sample population, so that their cognitive maps can be acquired and further analyzed using cognitive sketch drawings. Moreover, this research was limited to comparing two historical textures. Future studies should focus on the cognitive map acquisition of citizens based on a comparison of traditional and modern neighborhoods.

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