

Using Space Syntax to Assess Safety in Public Areas - Case Study of Tarbiat Pedestrian Area, Tabriz-Iran

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Abstract. In studying the urban complex issues, simulation and modelling of public space use considerably helps in determining and measuring factors such as urban safety. Depth map software for determining parameters of the spatial layout techniques; and Statistical Package for Social Sciences (SPSS) software for analysing and evaluating the views of the pedestrians on public safety were used in this study. Connectivity, integration, and depth of the area in the Tarbiat city blocks were measured using the Space Syntax Method, and these parameters are presented as graphical and mathematical data. The combination of the results obtained from the questionnaire and statistical analysis with the results of spatial arrangement technique represents the appropriate and inappropriate spaces for pedestrians. This method provides a useful and effective instrument for decision makers, planners, urban designers and programmers in order to evaluate public spaces in the city. Prior to physical modification of urban public spaces, space syntax simulates the pedestrian safety to be used as an analytical tool by the city management. Finally, regarding the modelled parameters and identification of different characteristics of the case, this study represents the strategies and policies in order to increase the safety of the pedestrians of Tarbiat in Tabriz.

1. Introduction

Great attention is paid in all over the world to basic needs of citizens in urban environments and to solving their problems and dilemmas. Accordingly, increasing safety in urban public spaces is the most important concern for planners and designers [1]. In this perspective and specifically from urban city planners' point of view, walking paths and sidewalks are the most significant components of urban public spaces, so systematic and organic characteristics of hierarchy in accessing them, the type of design, lights, spatial layout, etc. may play a very effective role in the sense of safety [2]. Generally, urban public spaces noticeably increase, according to Jane Jacobs, the probability of the occurrence of criminal behaviour [3]. As the urbanization rate increases, and the urban scale grows, the ambiguity in public areas also rises. The cause of this ambiguity is the unwillingness of citizens for inappropriate urban places that threaten the sense of safety. The spread of urban space will naturally produce a new urban morphology. The structure of the city is composed of a set of the spine and interconnected network of different users and varied elements of the city that generally makes the city coherent [4]. Taking a



look at the structural and the organizational skeleton changes in cities clearly indicates that lack of design rules and criteria. Its reflection in urban development is a gradual destruction on the structure of cities. One of the results of this urban disorder is a continuously increasing extent of unsafe and fragile places in public spaces. The aim of the present paper is to evaluate the impact of urban morphology structure on sense of safety in urban public areas by utilizing the components of the space layout in Depth map software and efforts were made to find answers to the following question:

- Does urban morphology affect the sense of safety in urban public spaces?

This study measures urban safety by applying questionnaires to the users of urban public spaces in Tarbiat's sidewalk. The results of the questionnaire were assessed in SPSS (Statistical Package for the Social Sciences) and solutions are suggested to improve the quality of urban public spaces for safety in the case of Tarbiat's sidewalk.

2. Theoretical Background to the Study

Sense of safety: Safety has always been recognized as a basic human need that can be socially defined in two dimensions: the subjective dimension and the objective dimension. The objective dimension addresses physical and social issues and the subjective one addresses the sense of safety that can be created with the environment. When put together, these factors make the safety of individuals in urban environment [5].

Urban safety: Urban Safety is not only a personal state and safety for the population, it is a complex notion, defined on the basis of several factors and formed in a given territory of the inhabited area. Urban safety is a combination of factors, including urbanization, architectural and ecological ones, which create favourable and safe living environment [6].

Without a doubt, no elements are more important than safety element for progress and sustainable development in a community. This topic in the city, which is the centre of civility and economic production, has a higher position. Usually the feeling of unsafety in metropolises, which have broader social interactions, in comparison with small towns, which have traditional contexts and social norms that cause adequate limitations to deal with unsafety, is more noticeable. Considering that the occurrence of any crime or social abnormalities require places and need a favourable environment, features of some of the urban places makes them places or spaces that are fruitful for crime. Historical and old context due to environmental conditions including physical and social features, become prone to crime [7]. The necessity of addressing the concept of "urban safety" has a double significance because looking at the growth of urbanization and increase of the urban population that leads to intermixture and merging almost all people in structure of the city. Therefore, this category can be used in connection with national security and social cohesion. Providing safety, security and consequently sense of safety cause self-confidence in citizens and subsequently like human resources, they will be able to play their role in development of economics, society, culture, and politics [8].

On this basis, identifying the factors and elements affecting the insecurity, safe and unsafe spaces, social security and sense of safety is considered as one of the fundamental prerequisites for citizens in planning and urban designing and has a significant role in government strategic planning [9]. In such circumstances, and considering Tabriz as one of the metropolises of Iran, one may discuss that consequence of the lack of sense of social security of citizens in this city has been considered as a social issue and needs to be checked. Generally, safety has a direct relationship with space and quality of the urban environment. One of the most important factors that has an effect on increasing the sense of insecurity is the lack of spaces in an urban structure [10]. Space intelligence is defined as the unit, which is described by the combination of two connected criteria and connections on space layout technique [11].

Table 1. A historical overview of the schools of thought regarding the notion of safety [5]

	Year	Schools	Functional Concepts
1	18 th century	Greek Schools (Aristotle, Socrates and Galen)	Individual traits of the criminal and how to deal with him/her
2	1890	Classic School, Positivism	Inner conditions of the individual (Biological, Psychological, Nurture- related)
3	1920	Chicago School	Place- related aspects of crime in cities
4	1961	Wood, Jacobs	Physical environment of crime
5	1980	New Urbanism	Patterns of establishing safety for designing urban areas
6	1990	CPTED, Defensible Spaces	Continuation of the use of environmental design to realize crime prevention components

3. Methodology

Nowadays, in the planning and designing of cities with large-scale tasks and broadness of the factors involved in the formation of urban projects, logical approach and their systematic processes have replaced artistic and intuitive attitudes. One of these approaches is an analysis of space structure with space syntax techniques, which can analyse the relationship between physical space and current happenings in it, gives the results in the form of graphical and mathematical data. This theory investigated the spatial configuration and spatial disciplinary and tried to find out its interaction with social structures, behaviours and activities of the users. The general idea of this theory is the possibility of decomposing the elements of space to its constituent and the analysing it as a network of connections and recall it in the form of maps and graphics expressing these relations and cohesion. These relations and coherences are in the form of components such as security, safety assured, the sense of comfort, the effective interaction between passers-by and configuring natural pathways of people in the space. Spatial configuration originally should be in such a way that the relationship between the communication routes and urban structure (urban form) has the most amount of space linkage. Increasing space linkage leads to the raise of the urban safety level and the spaces for presence of different strata in the community [4].

4. Case Study

Tabriz is located in East Azerbaijan, Iran. The scope of the study is the Tarbiat's sidewalk in Tabriz. Tarbiat's sidewalk was chosen as the case study because it is an urban public space that every segment of city uses it. Tarbiat's sidewalk is located in region 8 of Tabriz's municipality (Tabriz historical-cultural municipality). This range has urban organic structure because it is located in the central core of Tabriz, and generally has a historical and old urban fabric.

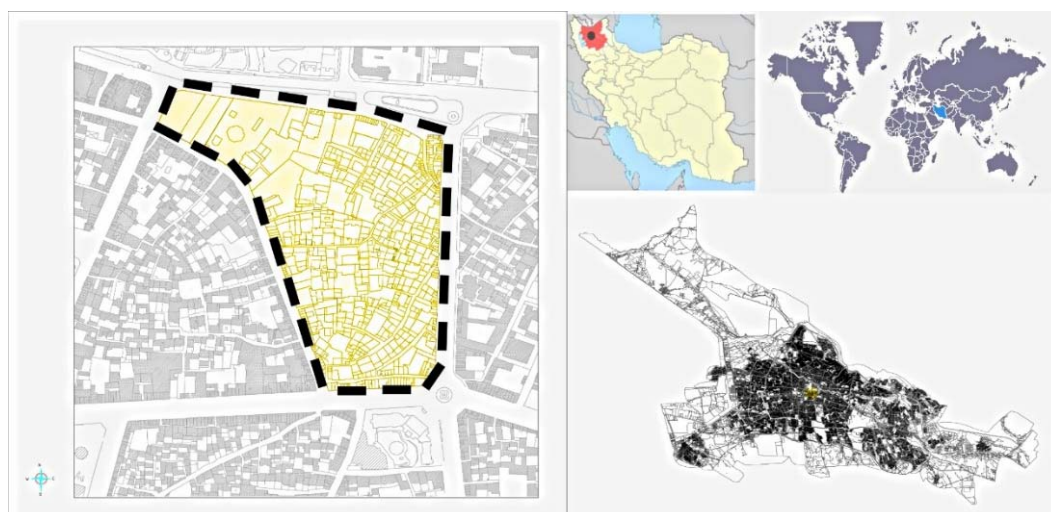


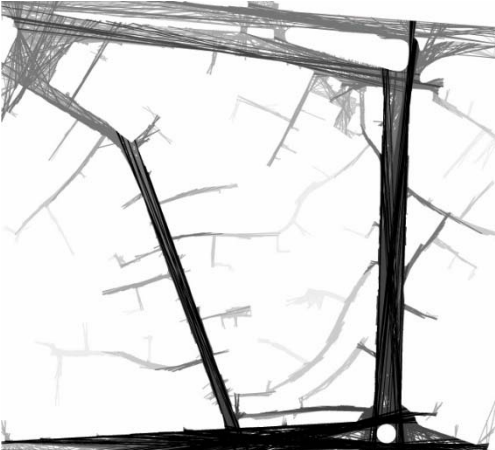
Figure 1. The position of the scope of the case study in the world, Iran, the province and the city of Tabriz, (Case data)

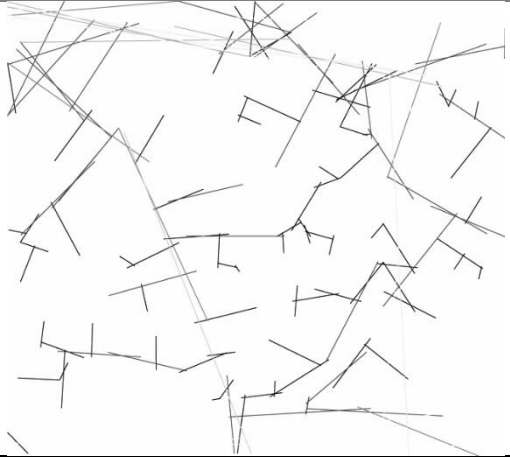
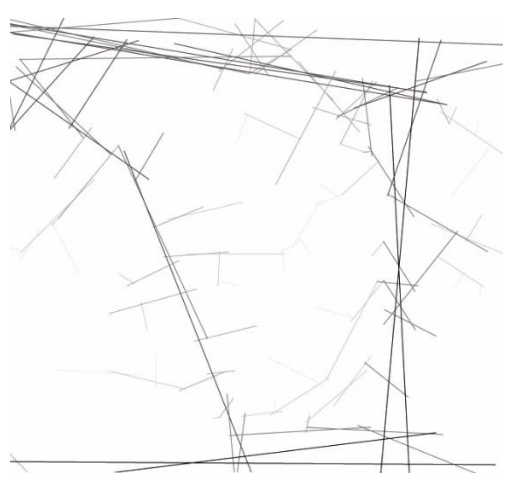
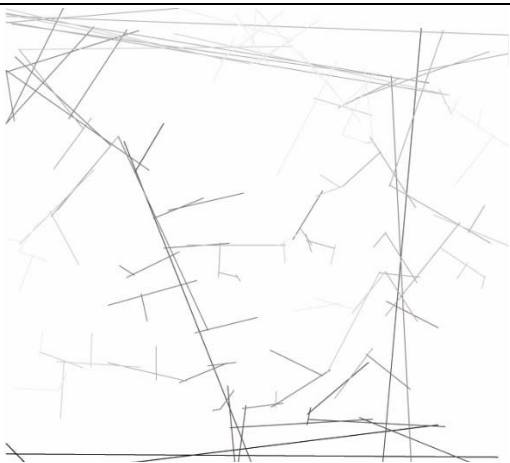
In order to do research, a questionnaire was set up and distributed among the residents and pedestrians walking within the scope of the study. Sampling was targeted have been considered as clusters, and inside it random sampling was done. The way of analysing the collected information was in a way that after providing information through a questionnaire, sex, age ratings and academic career were considered. Preparing of a questionnaire was based on the approach in which to search which features of the urban space strengthens a sense of safety, and how one space reduces the safety. Some of the cases that have been considered in this study are the amount of emptiness and commotion of places, the rate of brightness, the quality of the flooring in sidewalks and the structural features of the city.

5. Data Analysis

In analytic maps, linkage was less in spaces with high depth than in spaces with low depth. In other words, separate spaces have less linkage. Together with the increasing rate of linkage, the mean of spatial depth decreases. It is an obvious rule because spaces that ~~are~~ lead to spatial coherence and unity in the main body of the spatial layout of the city are those that also play a unity role. This means that spaces that are more accessible, have the highest level of safety. This subject simultaneously implies the existence of a strong relationship between a certain amount of depth and the linkage of that space. The more linked exist in a space the more it tends to move naturally. Spaces with a higher depth lack this property. The amount of tendency for natural movement also implies the increasing level of safety in space. In this case, the spatial- physical structure influenced by natural movement has a particular role in determining the deployment of market users like Bazar.

Table 2. Analysis of a spatial layout technique in the studied range

Map	Name of the map	Analysis
	Mean Depth	The amount of specific space separation from the whole space is called a space depth. Simply, this means that, for example, in a residential space within an alley the amount of space depth is more than a commercial space in the margins of a main city. In describing the colour spectrum in map of average space depth, red colour has the most amount of space depth and blue colour has the lowest one. Blue colours have the most unsafety and reds have the highest safety.
	Natural Movements	The most important and most effective factor in the creation of the movement in the city is the origin and destination. The relationship between the structure of the spatial arrangement of a city and the density of traffic in its spaces is called "natural movement". When the people passes the spaces with characteristics of spatial arrangement, they are in high population concentrated in those spaces, and is increased the congestion of traffic. An increase in traffic density has increased public surveillance and safety. The darker parts are safer than the other parts.

	Connectivity The most obvious parameter in morphological analysis is the connectivity. The conceptual meaning of that is the spatial connection. This means that the more linkage the more the number of desired connections to other spaces. The users meaning of it can be “access”. The higher the level of access is, the higher is the number of corners and places that are out of sight for pedestrians, resulting in a declining sense of safety in these places.
	Integration Integration is the most original concept of space composition, which is in accordance with the concept of spatial coherence. The value of the linkage per line (space) is a mean number of mediator lines (or spaces) which can lead us to all parts of the city; or in other words, it is a mean number of orientations that by using them one can access all parts of the city. The pattern of how to distribute the linkage in the city is in line with how pedestrians move in it, which in this process the scope of the study has the successful linkage rate with the spaces around the range.
	Intelligibility Intelligence is calculated through linking values of connections' parameters and the average depth of space in two neighbouring units and the overall scale. If the average value of the linkage in neighbouring scale is more than the same parameter is whole scale we say that the space is intelligent. This space is easily understood in the process of navigating and the audience can easily find it. The more intelligent the space, the more secure it is and the more one individual confused in one space the more unsafe it is. Dark lines have more intelligent.

Increasing the natural motion leads to the observer's eye enhancement in public space and this causes the safety of the urban space.

About the questionnaires provided from the scope of the study, the total number of data was 170 including 92 females and 78 males. Characteristics of the population are as follows, table 3.

Descriptive statistics, questions about the level of safety in the items related to old places, night activities, installation of CCTV cameras, bags and pockets robbery issues, the performance of the public transportations and finally the total safety of Tarbiat's sidewalk are as follows, table 4.

Table 3. Specification and characteristics of respondents (Case data)

Specifications of respondents by gender, age, level of education and occupation	
Diagram of the respondents in terms of gender	
Diagram of the respondents in terms of level of education	
Diagram of occupation of respondents in terms of gender	

Table 4. Safety issues in Tarbiat's sidewalk, (Case data)

Questions	The answer of pedestrians
1-What is the impact of narrow and dead end paths in the sidewalk?	Old tight and narrow passages make this sidewalk unsafe and citizens do not have a desire to use these old traditional streets.
2- What is the impact of public safety and traffic accessibility at night events? Are you satisfied with the performance of public transportation after the dark?	Respondents have shown their desire to further use these streets in case of an increased safety for night activities in restaurants and similar public places, which indicates the existence of necessary potential in these areas to attract people. More than half of the participants noted that the performance of public transport was inadequate and inefficient.
3- What is the effect of control cameras on ensuring and enhancing public safety?	More than 80 percent of the respondents feel more secure when (CCTV) cameras are installed along the way
4-What is the possibility of robbery on this sidewalk?	More than 50 percent of the respondents feel medium to high possibility of pocket robbing. They need to care about their shoulder bags or high-priced items (mobile phones).
5-What is the potential for verbal or physical harassment and irritation?	111 people from the 381 respondents (29 %) said that the amount of verbal or physical harassment in these places is very high and 103 (27 %) people indicated that it is high. It has been understood that is a social and cultural issue and that it causes a high psychological unsafety for women in this public area.
6-Generally, how do you evaluate the safety of Tarbiat's sidewalk in total?	The degree of popularity of Tarbiat's sidewalk in people's mind is somehow medium to high. The participants never find this place safe, but they define it as a historical place and reasonable for pedestrian circulation.

6. Results and Discussions

The mentioned urban safety factors classified by different characteristics would allow to conduct a detailed analysis of urban environment, therefore, determine the level of urban safety in a considered territory. The graphical findings of the maps analysed in Depthmap software shows that increasing the rates of connectivity, will strengthen the integrity between the urban spaces and the whole town. This parameter has a direct relationship with the amount of access as well; in other words, the spaces with the highest amount of linkages have an improved access to more places in comparison to others. Usually, these spaces are more commercial and are the main accessible points in the city. The mean depth of the space based on the configuration of a particular logic is a separation from all areas of urban spaces. Spaces that have much more depth are separated from their spatial configuration. The amount of the depth of space inside of the Tarbiat's sidewalk is the largest one, and these places are the most private spaces and they ensure safety for their residents. The analysed parameters of this research are in the form of mathematical data in three categories: minimum, average and maximum value and the results are as follows:

Table 5. Numerical form of analysed data, (Case data)

		Space syntax layout parameters				
		Connections	Integration	Mean Depth	Natural Movements	Intelligibility
Numerical form of analysed data	<i>Min</i>	1	1/3	11/46	2/02	0/65
	<i>Ave</i>	6/89	0/57	16/46	0/61	3/73
	<i>Max</i>	45	1/84	28/87	6/63	22/92

The findings of the questionnaire show that during the day 72% of women always and 4% of women just sometimes use Tarbiat's sidewalk for shopping. 24% of them do not use these areas for shopping at all and just use them for enjoyment and walking. At night, only 20% of women sometimes attempt to pass this sidewalk when it is necessary and in general used them as a pass. During the day, 46% of men always and 20% of men sometimes use Tarbiat's sidewalk for shopping and enjoyment. At night, these amount drops to 22%. These data are measured in SPSS software for parameters in the discussion about safety and results are as follows.

Table 6. Results of the performance tests, used for determining the relationship between age and the feeling of unsafety resulting from the bad flooring of Tarbiat's sidewalk and the possibility of falling, (Case data)

Significance level	Degree of freedom	Square X2	
0.006	12	27.679	Age and the feeling of unsafety resulting from bad flooring of Tarbiat's sidewalk and the possibility of falling

The results obtained from Table 6 show that calculated X2 ($27.679 = 2x$) with the degrees of freedom (12) in significance level of 0.006 is meaningful. This indicates that the age group of 46 years compared with the age group of 15 - 30 years in the issue of unsafety of bad flooring, feels more unsafe.

Table 7. Results of test to determine the relationship between age and a feeling of unsafety resulting from the existence of the ruins and deserted in the sidewalk, (Case data)

Significance level	Degree of freedom	Square X2	
0.011	12	25.819	Age and a feeling of unsafety resulting from the existence of the ruins and deserted in the sidewalk

The results obtained from Table 7 show that calculated X2 ($25.819 = 2x$) with a degree of freedom (12) at significance level of 0.011 is meaningful. This relationship was significant and indicates that the age

group of 15 - 30 years (youth) claims that the ruins and deserted places are agents in creating a sense of unsafety, compared to 46 years' age group.

Table 8. Results of test to determine significance of the relationship between ages and feel unsafe after dark, (Case data)

Significance level	Degree of freedom	Square X2	
0.000	12	36.081	Age and feel unsafe after dark

The results obtained from the Table 8 show that calculated X2 ($36.081 = 2x$) with the degrees of freedom (12) at significance level of 0.000 is meaningful. The age group of 15 - 30 years considered the sense of unsafety after dark close to 54 % to be very high while this factor for the group age of 26 years is reported 46% and the results suggest that feeling of unsafety after dark is higher in the young age group compared to the older age group.

7. Conclusions

There should be clear standards and norms for urban safety and for its assessment in urban areas. These standards should define a safe living ecology for the people. Monitoring and control of fragile areas via standards and norms could allow safer living conditions to be established.

According to the findings of this study, dark and isolated roads, abandoned or unfinished buildings, sharp corners, areas with low traffic density, unreachable places for pedestrians, spatial conflict between pedestrians and motor vehicles, worn out urban fabric and adaptation problems of people due to cultural differences are the main problems that reduce safety in urban environments, and often depend on the lack of a multidimensional approach to urban planning and design. Based on the analysis of the space syntax and the questionnaires, the final notifications and strategies specific to this study are described as follows:

- It is necessary to increase the use of urban public spaces and old paths to keep the depths of urban areas and create private spaces for residents of the neighbourhoods that will result in increased safety;
- The planning and design of old streets with historical values connects the past and the future and enhances the sense of safety;
- Enforcement of rules and regulations, and public monitoring will increase the attractiveness for pedestrians and thus, increase the sense of urban safety;
- The holistic and integrated planning approach will provide a better perception of the place, and this will also lead to an increase in the sense of urban safety.

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