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Analysis of residential complexes with the approach of space syntax in terms of mass crime

(Case Study: Shiraz Residential complexes)

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ABSTRACT: Various factors affect the degree of mass crime of an environment, including social, economic, and physical factors. The purpose of this research is to investigate the role of the physical components of an environment on mass crime rate. In this regard, open spaces between residential complexes were selected as the case studies and based on five outdoor patterns including linear pattern, dispersed pattern and open central courtyard pattern and closed central courtyard pattern as well as molecular pattern in five residential complexes was selected in Shiraz city. The analytical tool in this research is syntactic theory, and analyzes were carried out using Depthmap software. In this study, four indicators of "physical accessibility", "visual accessibility", "local access" and "universal access" as a research framework were formulated and case studies were analyzed based on them. Finally, an optimal final pattern with the lowest probability of mass crime is presented and the corresponding solutions are explained. The results of the study on the effect of outdoor design on providing space security with regard to the spatial access indicators showed that among the five proposed patterns, the central yard pattern and the closed central courtyard had the largest rate of space security. Other patterns including dispersed, linear and molecular patterns are in the next positions, respectively.

Keywords: *Mass crime, Residential complexes, Space Syntax, Depthmap Software.*

INTRODUCTION

INTRODUCTION

One of the important goals of space designing is a promotion of the quality of the human environment and (considering) the interaction between man and the environment. Any physical and social disorder in the human environment leads to inefficient space. The undesirable impact of daily collective spaces on increasing crime and social abnormalities are some of issues that exacerbate such tensions. Therefore, in order to reduce the environment's desire to support criminal acts, it is necessary to identify the factors affecting the crime and prevent it through environmental design (CPTED). One of the tools that can be used to identify massive areas in urban open spaces is the theory of space syntax. This theory is based on analysis of its components, including "depth analysis of spaces," the degree of our interconnection between different parts of the space, "the analysis of the amount of control and selection relative to the thin spaces," and "accessibility to different parts of space". The overall configuration of space is projected and, accordingly, predicts areas susceptible to crime. In this regard, based on these capabilities the present research has been designed to analyze the structure of open spaces of residential complexes. Moreover, it is examined the rate of crime of the desired patterns by studying different patterns, and identify the crime points in each pattern. However, the research questions are as follows:

Which of the five models including molecular, linear, open central courtyard, central courtyard, closed and dispersed in open spaces of residential complexes is better in term of mass crime reduction?

What factors influence the criminality of open spaces in different patterns of residential complex layout?

LITRATURE REVIEW

Many researches have been done on the issue of crime

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prevention and security in the environment. Broken windows theory proposed by Wilson and his colleagues in 1982 that used broken windows (These windows provide the opportunity to commit and prospect of crime at the city level) as a metaphor for disorder within neighborhoods on the ineffectiveness of urban design and architectural standards and norms examining the various dimensions of crime factors has been emphasized (Wilson et al., 1982). Oscar Newman is another researcher who has emphasized the need to have a trustee for different spaces by introducing the defensible space theory and introducing empty spaces without custody for committing crimes (Newman, 1996, 27). In another study, the effective factors in crime occurrences and crime prevention are described under the CPTED approach. Based on the results obtained three strategies for access control, natural surveillance and regional reinforcement are the most important in crime reduction (Atlas, 1999, 11).

In addition to the above studies in the field of environmental crime, the theory of syntax has also provided some ideas in this field. Hillier and Shu (2000) in Crime and Urban Layout book explore the role of urban layout types in crime prevention using syntactical tools (Hillier & Shu, 2000). In another study by Hiller et al., Space syntax theory has been used to provide a preliminary statistical design of the rate of mass crime in a variety of private and public spaces in some of London's neighborhoods (Hillier& Sahbaz, 2005). Recently, with the addition of computer tools for the theory of space syntax, as well as the entry of its three-dimensional versions, which help visualize the structure of the body in three dimensions, it is possible to provide comprehensive and accurate analyzes. So in this study, these tools are used to analyze the cases.

Many physical factors in determining the degree of environment of mass crime are effective. In the present study one of the most important factors, namely, the types of accessibility features and their role in anticipating crime in the environment will be examined. Beside the accessibility item, some indicators such as the degree of interconnection, control, selection, communication, etc. are also effective in changing the mass crime of the space. So, some of these factors are taken into account when examining the types of accessibility. In the following, briefly, the syntactic technique and its indicators used in relation to the subject matter are introduced and then with emphasis on the syntactic method a framework for crime prevention strategies is highlighted. Finally, some explanations are provided on types of blocks of residential blocks.

Introduction of syntactic markers for identifying the points of crime

The subject of crime and space is the idea of Oscar Newman in creating a defensible space. He explains several factors surrounding the crime of the environment. Based on his idea three components of the physical, social and economic aspects are the most important factors in the formation of crime in space, especially in residential complexes (Newman, 1996, 45). Along with this researcher, other researchers create defensible environments with a variety of methods. One of these methods is the use of syntactic indices (Hillier, 1988, 85), which in most of these studies, the crime rate by assessing various aspects of the environment such as complex roads and alleys which the probability of occurrence of crime in them is higher than other points of space is considered (Hillier, 2007, 183; Feng SHU, 1999, 134). Based on the opinion of these researchers considering the sensitivity of the issue of environmental crime, especially in residential areas, the use of tools such as a questionnaire for collecting information on crime points cannot be fully completed and can be generalized. This is due to the emotional and false positives that people sometimes have in their environment, and this affects people's perception of the crime rate of their place of residence (Feng SHU et al., 2003). For this reason, based on the foundations of space syntax experts in this field believe that in this method, due to the lack of interference of residents with their living environment and merely relying on the spatial characteristics of that environment, it is easy to identify the points where crime is more probability of occurrence. In this view, an indicator such as environment accessibility can have the greatest impact on this purpose. This concept can be explored in the theory of space syntax in the form of four types of accessibility, including visual access, physical access, local access and inclusive access (Saatci & Onder 2015). Each of these components has definitions and in analyzing the issues related to crime has a special rank. Moreover, it can be evaluated in the analysis of mass-related issues by the Depthmap software (Table 1).

Approaches of crime prevention (measurement)

In the following and after the recognizing and introducing syntactic factors that determine the degree of crime in an effective environment, the investigation of how these effects in changing the crime rate are among the major goals of this study. Each of the quadruple components has features which if those configure in the best case so it seem to be greatly reduced probability of occurrence of crime. In order to summarize and understand better, Table 2 presents the different conditions of each of the four factors and how it affects the probability of occurrence of the crime.

It needs to be explained that the examination of the physical or visual access which is traceable by the pedestrian only in parts that are located on the ground can be examined. As a result, by assessing the ground plan in two dimensions, it can be understood that its environmental characteristics. In this analysis, the edges of space are of great importance. Because of whatever we get to the center from the edge of the space, the probability of occurrence of the crime is reduced (Gil, 2015). Also, it is important to note that physical accessibility is largely influenced by the degree of space integrity. This means that as the space is more integrated, physical access to the semi-private spaces (which in this research is the open space between the residential blocks of the model) in the environment will be greater. As a result, the amount of control to that space is reduced (Hillier & Hanson, 1984, 90). Also, in relation to visual access, because visual capabilities are used to examine the environment and supervisors are also present in

Table 1. The factors of crime investigation and related software indicators

Investigating mass factors	Description	Utility factor	Software Tools
Visual access	Visual access means the amount of space that can be understood by the visual powers (in this assessment, the cone of vision is in all the target classes of research) (Lazaridou, 2013). Obviously, the cone study in three dimensions contributes to this analysis.	Visibility (3D) & Isovist	Image
Physical access	Physical access means checking the part of the environment that is moving through space for scrolling and seeing people. (In this research, only the open space among residential blocks is considered.) (Varoudis, 2011) Evaluation Convex spaces (without obstruction) and concave (which has a barrier to vision) contribute to this study (Hillier & Hanson, 1984, 27)	Visibility (2D) & Convex map	Image
Local admission	Local access means access to a certain radius of the environment (i.e., radius = 3 meters), which provides access (physical and visual) to a variety of spaces in this area (Hillier, 2007, 72)	Local accessibility	Image and graph
Comprehensive access	Pervasive access means space availability in terms of access to the whole physical environment (physical and visual) (Hillier, 2007, 88)	Global accessibility	Image and graph

Table 2: Measurement of quadruple accessibility in security creation

All kinds of accesses	Description
Visual	Since visual access is examined in three dimensions, the "volume" or "cone vision" in the environment should be applied and the base area of the cone should be the basis for the evaluations (Gibson, 1979, 71). (Since perpetrators rarely commit crimes in environments that are recognizable by visual accessibility, the larger the space between the two areas can be identified and seen in the more distant part of the ground, there are fewer areas of the probability of occurrence of the environment (Nasar, 1982; Griz & Amorim, 2015).
Physical	Physical access is measurable in two dimensions. With physical access, whatever visibility towards the environment is more direct, that part of the space is more readable. In return whichever angle is miles away, The amount of visual information obtained from the environment will encounter more problems. In other words, whatever the complexity of the environment is reduced (the environment becomes more visible), the probability of occurrence of the crime is lower (Dalton & Dalton, 2015). However, the ground area with considering of visibility limitation in blind point and inaccessible of users view is the basis for reviewing the amount of mass in the environment. Given the nature of the above component, whatever the area of the convex space is higher and reduce the number of types of obstacles (including tall trees and dwarves, etc.) to users (reduction of concave spaces), the probability of occurrence of the crime in the target environment will also be reduced (Turner et al., 2001; Beck, 2015)
Local	This factor is directly related to the degree of integration and connectivity in the environment. This space can be detected by the Depthmap software in various radii. With the software capability, whatever this factor (R2) is closer to zero, this is means that the degree of interconnection in the space is more appropriate, and the readability and clarity of environment has a better condition. In other words this condition causes a sense of safety in people and indicates a minimum level of criticality in the environment (Hillier, 2007, 73).
Comprehensive	This factor, like local access, depends on the degree of integration and connectivity and is investigated within the radius R2 = n (meaning the whole environment). Similar to local access, whatever this value is closer the zero, the legibility of the environment is enhanced, and the degree of criticality in the environment related to the overall access component decreases (Hillier, 2007, 124).

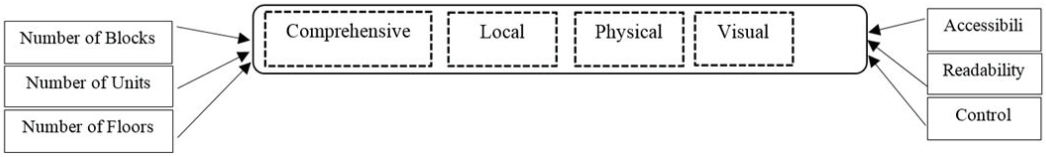


Fig1. Conceptual Framework

the classes, offenders are less likely to commit a crime in such environments. As a result, there are points in the environment that, although not accessible by human physics, can be detected by the eye. Therefore, the range of visual access is greater than physical (Griz & Amorim, 2015) and cannot be considered alone by examining the ground plan (Fig. 1). It is also used to check the amount of local and comprehensive accessibility to the radius of space. In addition to image analyzes for better evaluation, the connectivity graph will also be used.

Recognition the types of open spaces in residential complexes

The environments that are public area or shared between residential blocks are belong to a large number of households because they do not feel the sense of belonging and identity to the particular space so those are disregarded by people. After some time, this causes some problems that make the environment unsafe. On the other hand, when private property is not concerned, it is difficult to identify the perpetrators of the environment, which also contributes to the occurrence of crime in the space (Newman, 1996, 30). In this study, to determine the amount of outdoor activity in residential complexes, the proposed theories to be tested in case studies. Given the subject of research, these cases have been selected among the patterns of residential complexes and open spaces between them.

By examining the case studies of residential blocks in Shiraz, it is clear that open spaces in these complexes are formed depending on the type of residential blocks in five patterned including dispersed, linear and closed central courtyards, an open central courtyard and a molecular pattern. Table 3 shows the characteristics of case studies used in this study.

Table 3. Introducing case studies and different layout patterns

Name of complex	Blocks No.	Unit No.	Floor No.	Form pattern	Site plan	Image
N astaran-Mikhak	16	26	4	dispersed		
Yas	6	6	8	closed central courtyard		
Laleh	7	23	5	open central courtyard		

Continiue of Table 3. Introducing case studies and different layout patterns

Name of complex	Blocks No.	Unit No.	Floor No.	Form pattern	Site plan	Image
Arg	23	24	5	linear		
Goldasht	46	61	7	molecular		

MATERIAL AND METHODS

This research is a descriptive-analytic method and attempts to investigate environmental factors and, in particular, some of the open-source physical factors of several residential complex patterns. In order to evaluate such conditions in residential blocks, first three open spaces including linear forms, central courtyard and dispersed blocks selected. Then, using space syntax components and theoretical framework, these patterns were analyzed and the results were explained and summarized. In this study independent variable is a structure of the open space of the residential complexes, the dependent variable is the crime rate and the mediator variable is all kinds of space access capabilities. Figure 2 shows the research process.

RESULTS AND DISCUSSION

Software analysis of samples

As explained earlier, investigated software in this study has been done using the Depthmap software. It is worth mentioning that the 3D part of the Depthmap software is currently in the early stages of production and is not available to the public, and the examples are purely research that introduces the elementary dimension of this dimension. Therefore, in the graphs and tables for visual access that requires 3D analysis, the Isovist software.

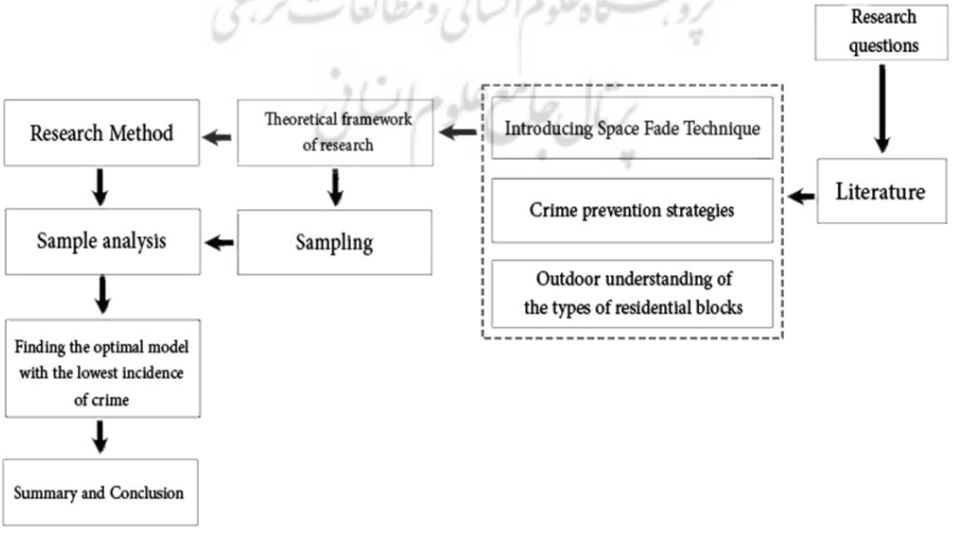
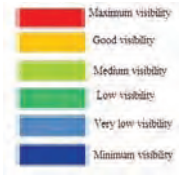
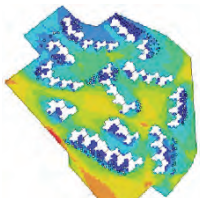
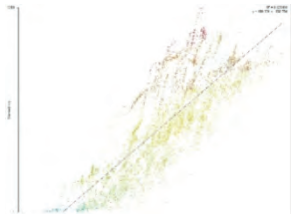
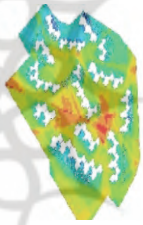
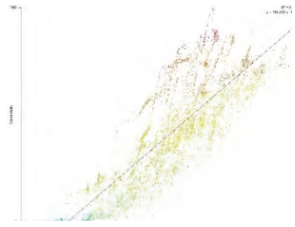
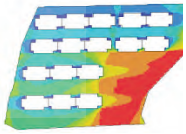
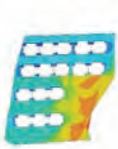
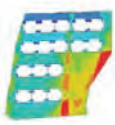
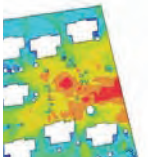
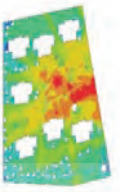
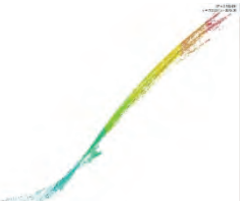
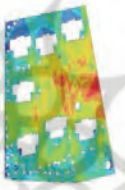
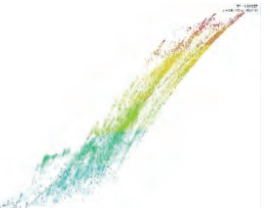
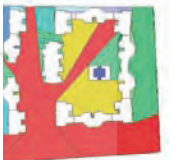
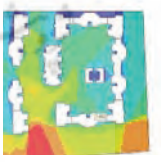
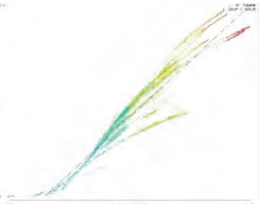


Fig 2. The research process

Table 4. The results of analyzing case samples in the Depthmap software

Complex	Quality access	Pattern complex
Molecular Pattern Goldasht CompleX	Visual access	 
	Physical access	 
	Local access	 
	Comprehensive access	 
Linear Pattern Arg Complex	Visual access	 
	Physical access	 
	Local access	 
	Comprehensive access	 

Continiue of Table 4. The results of analyzing case samples in the Depthmap software

Complex	Quality access	Pattern complex
open central courtyard Pattern Laleh Complex	Visual access	 
	Physical access	 
	Local access	 
	Comprehensive access	 
Close central courtyard Pattern Yas Complex	Visual access	 
	Physical access	 
	Local access	 
	Comprehensive access	 

Continiue of Table 4. The results of analyzing case samples in the Depthmap software

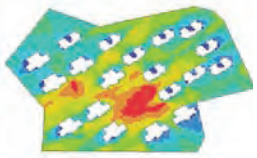
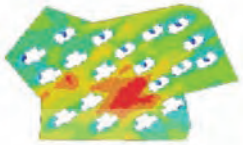
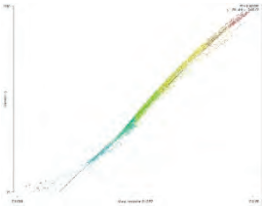
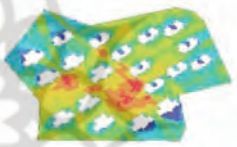
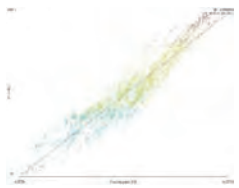
Complex	Quality access	Pattern complex
dispersed Pattern Nastaran-Mikhak Complex	Visual access	 
	Physical access	 
	Local access	 
	Comprehensive access	 

Table 5. Quantitative results analysis of case samples in the Depthmap Software

Complexes/ Parameters	molecular pattern		linear pattern		open central court-yard pattern		dispersed pattern		closed central court-yard pattern	
	Unit	Percent of total	Unit	Percent of total	Unit	Percent of total	Unit	Percent of total	Unit	Percent of total
Maximum available area sight	15545.8	13.09	7751.9	27.73	4942.95	24.00	9054.81	24.86	7891.72	24.18
Minimum available area	423.04	0.35	532.83	1.90	397.05	1.92	2467.7	6.77	1267.63	3.88
Sight										
Total area	118760.37		27947.45		20588.64		36416.09		32631.54	
Maximum physical access	1288		4470		6474		1685		3566	
Minimum physical access	1		28		14		25		46	
Maximum Local access	14.86		26.09		19.26		15.01		21.03	
Minimum Local access	0.21		8		7.85		7.64		6.63	
Maximum Comprehensive access	9.28		20.84		18.83		14.69		19.12	
Minimum Comprehensive access	2.39		4.05		5.12		4.95		4.25	

Visual access

This type of access is evaluated based on the rate of natural human vision level at a 120 °. In the obtained results (Table 4), red color means the maximum visibility area and the blue and green colors have the lowest visibility. In this analysis, it is assumed that due to the existence of units of residence sometimes in different classes of buildings, it is possible to see the area by inhabitants in the sections where the window is located. As a result, the probability of occurrence of crime in these parts of space is less than other parts that are not visible by the visual power. Based on the images from the analysis of the visual accessibility of outdoor space among residential complexes (Table 4), it seems that the control of individuals relative to the mediate open space in linear patterns complexes, the open and closed central courtyard, and the dispersed pattern the amount of control over this space in the molecular set is much higher. This means in the four type of complexes, the area of view is more visible from the courtyard, and therefore people can see more levels of the yard than the molecular pattern. However, in blocks of residential complexes with a molecular pattern, due to vegetation and asymmetry of the layout and location of blocks, the most visible space is located in the west and southwest of the complex and the center of the blocks is less attention. This confirms that the intermediate space in these blocks has less relative control than the patterns mentioned above. Also, by examining the data in Table 5, which is extracted from software analyzes, it can be seen that in complexes with open central closed and closed pattern, as well as in the dispersed pattern, in most cases, 24% of the total spaces are available for residents and this amount is 27% in the linear model. However, in the molecular pattern, only 13% of the total space-based space surveillance of inhabitants to open spaces in residential complexes with molecular patterns compared to other patterns.

Physical access

Residential blocks and other elements that prevent users from viewing space will create concave spaces. Since more than half of the space is occupied by residential blocks, the highest levels of concave spaces are formed in the middle sections of the complex, while convex and spacious spaces are most visible in the peripheral spaces of the complex. As seen in physical access analysis, in the two patterns including dispersed patterns and the central courtyard, the greatest amount of physical access has occurred precisely among the blocks, while moving away from the open space and moving toward the blocks the amount of physical access is reduced. In spite of this, according to the data in Table 5 (analysis of complexes), the maximum physical access to the middle sections of space in the three linear patterns is the closed open courtyard. This means that the largest unobstructed open space (with the largest area) in front of the user's visibility is in the courtyard of these residential complexes, after which the patterned blocks are scattered, followed by a molecular pattern in the next ranks. This is despite the fact that the smallest barrier space also belongs to dispersed blocks. It is also observed by examining software images that the edges of spaces in each of the 5 sample cases have the least physical access to the spaces specified in red (Table 4). This shows the importance of the edges in creating a secure space in residential environments.

Local and comprehensive access

Local and comprehensive access explores the rate of readability and clarity in space. As noted above, whatever, the rate of the degree of space interconnection in the entire set is grater, and the level of communication is also more appropriately defined, the spatial separation rate decreases and, as a result, the permeability increases to the total space. Performing the process in the environment will increase readability in space. The lack of readability in space and, consequently, the complexity of space, provide an introduction to the mass of crime and crime in the spaces and environment. Looking at the local access charts in the obtained images and the results from the numerical table, it is observed that the highest local access value belongs to the linear pattern blocks. After that, blocks with close central courtyard patterns and open central courtyards have the most local access. However, scattered and molecular patterns have less local readability than the previous three patterns. Regarding the overall accessibility or overall readability of the space, the complexes with linear patterns, the close central courtyard and the open courtyard have better conditions than the two dispersed and molecular residential patterns. This seems to be due to the dispersion and non-regularity of the block layout as well as the large number of blocks. It should also be noted that with respect to the numbers obtained from graph and visual analysis (R2), it appears that all five of the examined patterns have a relative spatial complexity. Since the number of R2 in all patterns is less than 1.

CONCLUSION

This study investigates the accessibility of space as one of the most important physical and structural factors related to the problem of crime and mass of crime in space. This is important in related to residential which by as full time. Accordingly, the present study, with emphasis on the issue of crime and the study of the security on open spaces between residential complexes, has chosen the general realm of housing as the main bedrock of research. In this regard, five patterns including molecular, linear, open central courtyard, closed courtyard and distributed pattern as the base patterns are selected and based on these, five residential complexes in Shiraz selected. These complexes have combined the structure and shape of the blocks of these five patterns as case studies. After reviewing, the results of the research on the effect of open space on space security according to the spatial access indicators showed that among the five models the pattern of open central courtyard and closed central courtyard suggested the highest level of space security and the dispersed, linear, and molecular patterns are located in subsequent positions respectively. Moreover, the pattern of the central courtyard is more secure because of the increased

visibility and the possibility for more residents to dominate the open space between the blocks (because there are fewer blind points in central courtyard pattern, which leads increase security rather than other patterns).

Considering the above process, in addition to the physical features and the creation of an optimal model, suggestions are made regarding the promotion of space security in the environment along with the selection of appropriate patterns that include:

1-Lack of long-standing trees in blind points and space around the blocks;

2-Use of proper lighting at night, with all the points and space around the area with enough light;

3-Proper placement of elements and a variety of urban indicators to avoid creating inaccessible visual points;

4-Creating a space as a guarded space in places where blind points are visible;

5-Providing relative security by installing CCTV cameras around the premises and the open space and inadmissible locations;

6-As much as possible, the edges and corners should be designed in such a way that visual visibility and visual access such as this distance is completely eliminated by moving away from them, 7-Having spacing and creating an appropriate space between the blocks for the visibility of individuals to the sides of the blocks.

It should be noted that the study of security and mass of crime in residential environments requires the consideration of several factors that it is not possible to include them in this research and can be considered in future research.

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