



An analytical study on the amount of visual dominance of high-rise buildings on the surrounding texture (Case study: The adjacent residential texture with the Alton Tower, Mashhad)

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ABSTRACT

In recent decades, there has been a great desire for high-rise buildings in the texture of different cities of the country. This phenomenon has advantages in the case of weakness in the principles of planning and design, as well as negative effects. The issues related to high-rise buildings include their location and adaption to the surrounding urban texture. Among these, an important issue is the visual dominance of high-rise buildings on the surrounding spaces and buildings, which violates the privacy of the surrounding buildings, especially residential buildings. A review of research shows that few studies have investigated applied methods to analyze high-rise building visual dominance on the surrounding texture. The most important goal of the present study is to analyze the visual dominance of high-rise buildings in relation to the surrounding texture by providing a practical method. The present simulation and modeling method is used in a two-step process using GIS and Rhino software and the Grasshopper plugin for data analysis. The visual dominance of the Alton Tower in Mashhad is studied and analyzed as a sample in the present study. The results of the present study include introducing the analysis method and steps in examining the visual dominance level of high-rise buildings on the surrounding texture. Moreover, recommendations are provided to minimize the visual dominance level of high-rise buildings on the surrounding texture.

Keywords: *High-rise building, Visual dominance, Privacy, Rhino software*

1. Introduction

High-rise buildings can be considered one of the signs of modern architecture and urban planning. In our country, there has been a great desire to high-rise buildings in different cities in recent decades. The tendency toward high-rise construction, as one of the strategies to control urban development, has intensified in recent decades due to factors such as the increasing urban population, the increasing demand for housing, and the lack of suitable land for urban development. Despite the advantages of this phenomenon in the case of weakness in the principles of planning and design, it has wide negative effects. The issues related to high-rise buildings include their location

in urban textures and adaption to the surrounding texture.

In many cases, the location of high-rise buildings in residential textures is such that it has no adaptation to the surrounding residential and small textures. In this regard, an important issue is the visual dominance of high-rise buildings on the surrounding urban textures and their negative impacts on providing privacy and private space in the spaces around such structures. Throughout the history of Iranian urbanization, the principle of privacy is a concept that has been one of the most significant principles in the past architecture and urban planning of this land and is rooted in the values and teachings of the Islamic culture and

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religious beliefs, which has been effective in identifying Iranian-Islamic cities. In the conditions of contemporary urban planning of the country, the principle of privacy has not been observed in urban textures at different scales and levels with the unregulated increase of building density. An important and key issue is the location of high-rise buildings within an urban texture so that it has a minimum amount of visual dominance over the surrounding space and does not harm the privacy of surrounding buildings and spaces.

A review of the research background shows that studies in various fields, such as the proper location of high-rise buildings in the context and urban texture [1], guidelines and strategies for locating high-rise buildings in the historical textures [2], the effects of high-rises on environmental quality in cities, and the negative effects of high-rises on the visual comfort of residents in the vicinity of these towers [3], as well as the issue of privacy in the spaces of residential towers [4], are reported in global research. However, the issues related to the subject of visual dominance of high-rise buildings on the surrounding texture are absent.

In domestic research, however, some studies have pointed out the necessity of observing the correct location of high-rise buildings in the urban texture [5]. Strategies have been proposed regarding the protection of the historical urban landscape, the necessity of observing a certain elevation line in the area of historical places [6], simulation of the optimal percentage of openings, an optimal angle of louvers, and optimal glass in a high-rise residential building using Design Builder software on different fronts of the building to reduce energy consumption and lighting The building [7]. Nevertheless, no study specifically focuses on the issue of visual dominance of high-rise buildings on the surrounding texture, and few studies have provided specific and practical methods to study and analyze the effects of this issue.

Accordingly, the present study seeks to answer the following questions. How can the effects of high-rise buildings' visual dominance be analyzed on the surrounding texture? What range, depth, and levels of surrounding space are affected by the visual dominance of high-rise buildings? The most important purpose of this research is to analyze the visual dominance of high-rise buildings in relation to the surrounding texture by providing a practical method. The case study of this research is located in the city of Mashhad., where the tendency toward high-rise construction has spread in recent decades,

and the criteria and indicators for locating high-rise buildings and their adaption to the surrounding texture are not observed in many cases. The present study examines and analyzes the Alton Tower in the central part of Mashhad and the effects of this tower in terms of visual dominance on the surrounding residential neighborhood.

2. Literature Review

High-rise buildings The height of a building is a relative one, and from different angles, various definitions have been proposed for high-rise buildings. Urban planners and designers often refer to ten-story and taller buildings as high-rise buildings [8].

A tall building is not specifically defined by the number of floors or its height, but an important feature of these buildings is that the design or function of the building is influenced by a symbol of height [9]. High-rise buildings have been defined in several ways, each of which has defined high-rise buildings from its own perspective. The definitions of high-rise buildings have changed over time and in different places. According to the rules and regulations of the Supreme Council of Architecture and Urban Planning of Iran, approved in 1998, high-rise buildings in Iran are referred to as buildings with more than six floors. According to the rules of these regulations, any building that is higher than 23 meters is considered a tall mansion [10]. In general, a high-rise structure is one that is higher than the maximum possible access to existing firefighting equipment. In absolute numbers, this amount includes a different number between 23 and 30 meters or 7 and 10 floors (depending on the distance between floors) [11].

Table 1. Minimum building heights in European countries [8]

Height (meters)	Country	Height (meters)	Country
23	Sweden	25	Austria
23	Swiss	25	Belgium
24	United Kingdom	22	Denmark
13	Netherlands	22	Germany
22	Norway	28	Finland

Privacy and visual dominance

One of these inherent needs is the human's desire for privacy. In Islam, high attention has been paid to privacy, and this issue has been recommended to Muslims. In the Holy Quran, there are several references to the issue of privacy and its protection. The issue of entry permits to enter residential units has been emphasized in this sacred book. , Verses 27, 31, and 61 of Surah Noor, as well as verse 23 of Surah Nisa and verse 80 of Surah Nahl, emphasize respecting the privacy of others and not encroaching on it even through direct vision. Due to the profound impact of Islamic values on the culture and beliefs of the people in Iranian society and attention to this human need, the principle of privacy in architecture and urban planning has emerged throughout the history of urbanization in this land.

In the urbanization system of Iran, urban neighborhoods have had a special position in the city as the urban life of Iranians has existed at three levels home, neighborhood, and city. Thus, the neighborhood was considered the basic unit of the physical-social structure of historical cities. On the other hand, the spatial organization of most historical cities of Iran has been based on the connection between the city center and neighborhood centers through main passages and squares and thus the neighborhood space had a special role. Moreover, neighborhood planning and design are considered an important issue in contemporary urbanism. Explaining the principles and criteria for urban neighborhood design, including the principle of unity, and contemporizing its principles and criteria are very important in contemporary conditions. The observance of the principle of unity has led to the discipline, cohesion, and integrity of historical neighborhoods [12].

The concept of privacy in Iranian-Islamic urban planning is manifested by various principles. Privacy has a direct relationship with the principles of hierarchy, introversion, and territory. In other words, the formation of these principles in urban contexts will allow for creating the principle of privacy. Providing privacy in cities is considered an important matter due to the extensive changes in the physical structure of neighborhoods and changes from traditional construction patterns to apartment and tower building patterns [13].

Territoriality is a factor affecting environmental security in residential complexes, however, it will significantly reduce destruction at the complex

level. Territory is considered a part of residential complexes used by an individual or a group of people for personal gain and defense because of their sense of belonging and ownership of the place. Any personalization and marking in the environment or protecting an area from harassment is a kind of territorial behavior. Improperly separated public realms in residential complexes will cause chaos, and will reduce the security of residential complexes [14]. In general, the higher the density pattern, the more dominance it is than the adjacent buildings [15].

Eyesight and visual dominance

Eyesight is the most important sense of the five senses in the perception of the urban environment. Among the various human senses, eyesight is the most developed sense. At a distance of 300-500 meters, humans see a blurry image of each other based on light conditions and background. By reducing the distance to about 100 meters, people will be able to identify each other's movements and postures. The age and sex of another person will be recognizable from a distance of 50-70 meters, and the hair color/physical condition and physical characteristics of the person can be seen only in this distance. At a distance of 22-25 meters, people can also perceive each other's feelings. As the distance decreases, more details become visible, and the person enters the field of human vision. Only a little information is understood at a distance of 25-100 meters. The social scope of vision can be discussed in the category of urban design, where the connection between the senses, communication, and dimensions is the main factor. This range is 100 meters away where people can be seen moving in space. After a distance of 100 meters, a distance of 25 meters is another important distance in the field of urban design. In this distance, people analyze each other's movements and facial expressions. Therefore, it is not surprising that these two distances are the basis of the design of any physical camp that focuses on the possibility of observing people [16].

Distance is one of the most important aspects of working on human senses in public space. Most urban space scales are very large in relation to human motor and sensory potential. With all the technological and social advances, we are still bipedal creatures, about 175 cm tall, and with a mostly horizontal field of view; we have clear limitations on seeing objects, distances, and angles of field of view. The sense of sight allows us to detect human movements from a distance of 100

meters, but we need a much closer distance for social interaction and detail recognition. It affects how we regulate our environment - regardless of where we are. Naturally, the best kind of experiment is to attend public spaces and feel the space with your body to see if the space looks big, small, or large. Personal experience is always the most useful tool for understanding spatial and scale relationships. As soon as we personally measure, collect, and organize our observations and samples, the meaning of concepts, such as human scale, human senses, and needs, fits in better with us [16]. Any calculation of human reactions to positions must include changes in levels. The following floor creates intimacy, inferiority, closeness, and fear. Upstairs, inspire joy, command, superiority, publicity, and passion. The act of descending leads us to the known, while the act of ascending leads us to the unknown. Strange correlations are found at similar levels along a deep gap [17].

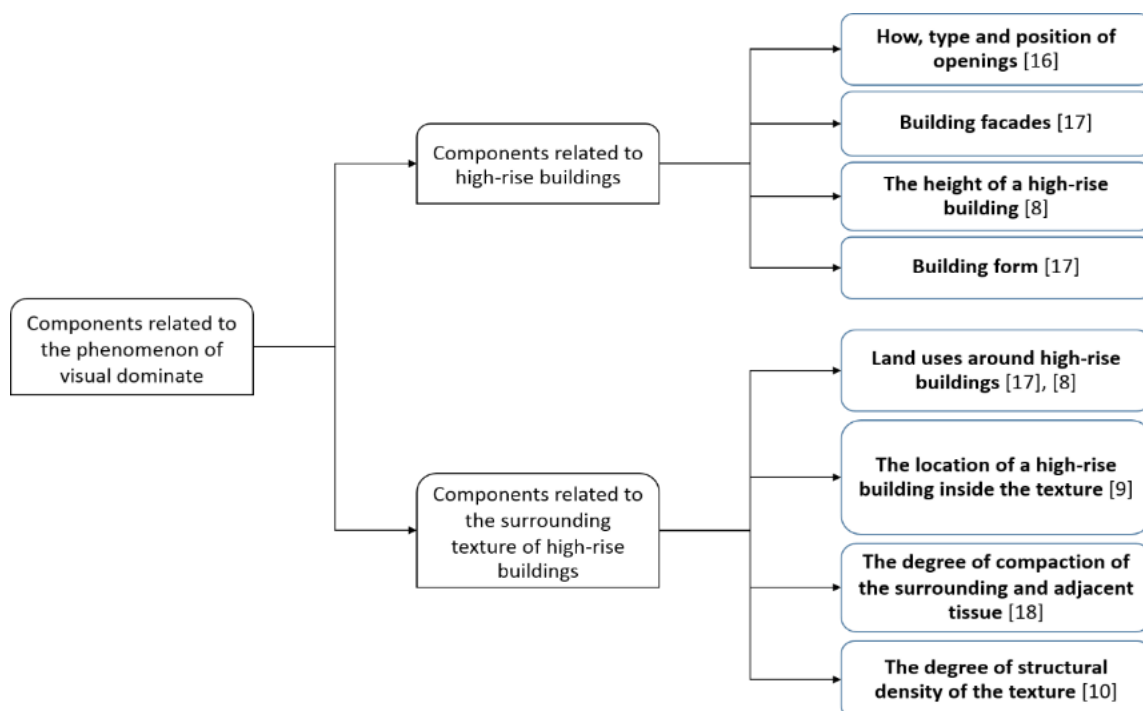
Urban landscape analysis requires a vast amount of data, the measurement of which on a small scale is not only time-consuming and costly but will never be used in some sectors. Many structuralists, such as Edmund Bacon, believed that it was not possible to perceive all parts of a city at the same time because of its size. Therefore, a part of the city

should be selected as the essence and main structure. Making changes in this part should provide the possibility of development and continuity in the whole city. Nevertheless, new computer quantitative techniques have largely overcome this limitation. Researchers have explored many different tools for quantifying the visual quality analysis of the environment. The place of view, field of view, angle of view, direction of view, and distance of view are some of the variables that have caused many complexities in the study of vision in the city because most landscapes in the city have all the variables. New studies have shown that 3D visual analysis criteria are more effective than 2D criteria because the height factor is not considered in the latter. In the real environment, however, changing the height dimension is one of the main factors in the physical perception of the environment [6].

This section introduces some components and criteria that affect the element of human vision and visual dominance of high-rise buildings on the surrounding texture. These components can be divided into two general categories:

- a- Components related to high-rise buildings;
- b- Components related to the surrounding texture of high-rise buildings.

Chart 1. The conceptual model of research



3. Research method

In the present applied research, was conducted with an inferential and analytical approach. In the present research, the analysis process uses specialized software to analyze the issue of the visual dominance of high-rise buildings on the surrounding texture. Data obtained from surveys and field studies were analyzed with applications such as GIS and Rhino as well as the Grasshopper plug-in. Rhino software is used in creating three-dimensional models and designing in various fields, including architecture and urban planning. The Grace Hopper plugin, which is installed in new editions of Rhino software, is also used in a variety of simulations and algorithmic and parametric designs.

The neighborhood space around the Alton Commercial and Office Complex was modeled by Rhino software and the Grace Hopper plugin. This powerful plugin is actually a graphical (visual) programming language; this means that different algorithms can be produced by considering specific parameters for it without the need for coding and learning the basics of programming, just with tools and graphic buttons. Parametric and algorithmic designs can be changed and edited using Grace Hopper, which is usually considered an interdisciplinary software or tool because it can be used to make connections between different disciplines such as architecture, civil engineering, product design, physics, structure, energy, mathematics, urban planning, modeling, facilities, electronics, Jewelry, etc. Filling this gap between different disciplines leads to the more logical process of constructing parametric projects that operate on specific patterns.

As mentioned above, Grace Hopper runs on the Rhino program space, meaning that access to Rhino software tools is also possible when using the Grace Hopper plugin, which is a great advantage. In fact, the user drags the desired tools to the model to Grace Hopper (drag) and sees the result in the Rhino view window.

Research case study

The case study of the present research is the study and analysis of the visual dominance of the Alton Commercial-Official Tower with a height of 75 meters located in the central part of Mashhad. The texture of this area is often checkered and is strongly influenced by this high-rise complex due to the location of residential buildings and

apartments around the Alton Tower in terms of visual dominance and privacy.

The Alton Tower is one of the tallest towers in Mashhad with a height of 75 meters. In this 24-floor tower, five floors are underground, one is the ground floor, and 18 floors are above the ground floor. It includes four commercial floors and three official floors, and the remaining floors of this tower are dedicated to parking. Commercial-official land use is defined for this tower.

More than 85% of the surfaces around the Alton Tower are residential land uses. The height of all is between 2 and 7 floors (less than a quarter of the height of the tower), and there is a low distance between most buildings and apartments. Thus, a direct view is created into the courtyards, buildings, balconies, and other private spaces of the surrounding buildings, which leads to the loss of privacy. In the following, the physical and visual dominance of the Alton Tower on the surrounding texture is shown in the form of maps and pictures.



Figure 1. A view of the Alton Tower in Mashhad and its visual dominance on the surrounding texture

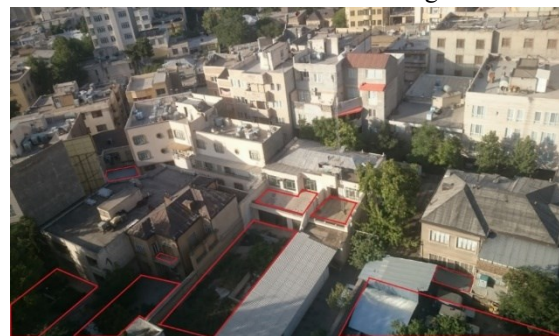


Figure 2. Visual dominance of the Alton Tower on the surrounding texture and direct and immediate view into the courtyards, balconies, and adjacent private spaces
Steps of the research process: the two stages of research are introduced in this section.

Step 1. Preparing a basic map for studies

Basic information was collected using the reference location database of Mashhad City. First, the study area is separated from the map of the reference location database and the map of Mashhad. Based on the height field of the building, the 3D model of the Daneshgah neighborhood,

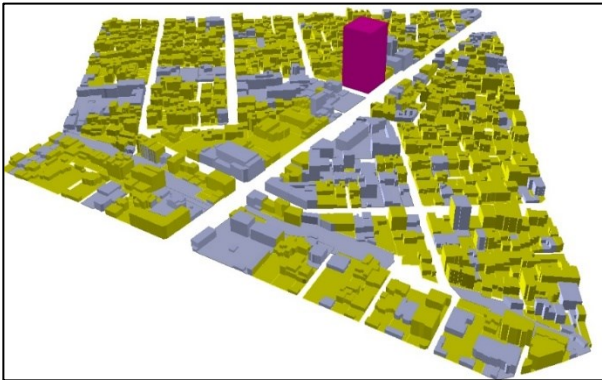


Figure 3. The 3D model of the residential texture around the Alton Tower based on the Mashhad GIS database

Step 2. The simulation process of the Alton Tower and its effects on the surrounding texture

After meshing the ground surface and the surrounding buildings, specific points were predicted for the angle analysis on the tower floors. Thus, a set of points in the height of a human angle of view (1.7 meters) was considered for each floor. The simulation was performed for 19 floors of the Alton Tower, with most of the visual dominance on the surrounding spaces. The simulation results are presented in intervals as a percentage. Thus, the higher the angle of view, the greater the dominance of the surrounding buildings. This is defined in the range of 0-100. Green (zero percent) means no dominance of the points of the simulated floor to the surrounding texture, and red (100%) means complete dominance of the points of the simulated floor. Middle colors mean moderate dominance. The reason for this is the lack of the same dominance of all points to the area under analysis so that there may not be dominance or non-dominance on all sides of a floor for a certain area on the ground. There is the utmost dominance due to the limited depth of vision for humans (up to a radius of 100 meters). The dominance is reduced from a radius of 100-300 meters, and the

including the Alton Tower and the surrounding texture, was then chosen to prepare a 3D map and import it into Rhino software in wrl format. The map information was modified and supplemented by field studies conducted inside the texture around the tower, and then the desired analysis was performed on the case study.

dominance does not make sense for distances greater than 300 meters. Then, the results of modeling and graphic analysis as well as the output of Rhino software and Grace Hopper plugin based on different floors of the Alton Tower and its dominance over the surrounding texture were presented based on the process described in the previous steps.

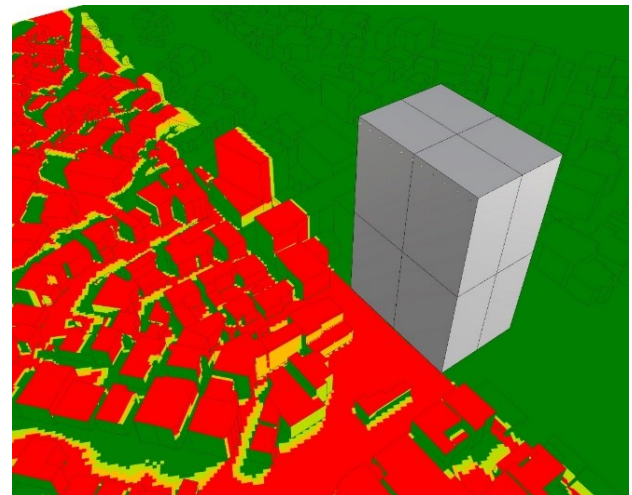
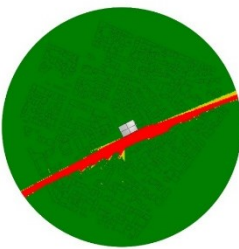
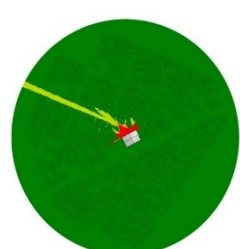


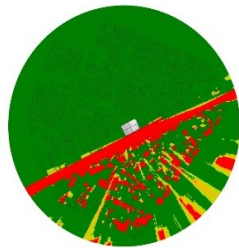
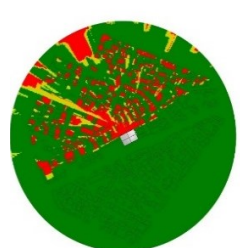
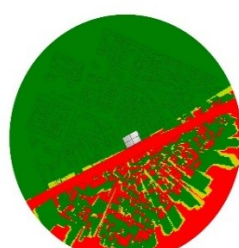
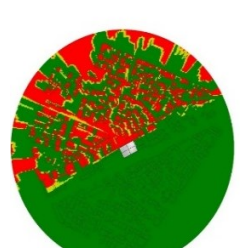
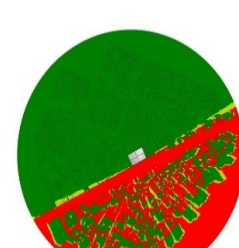
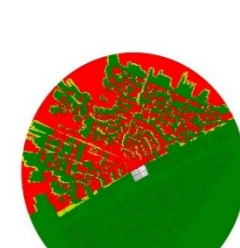


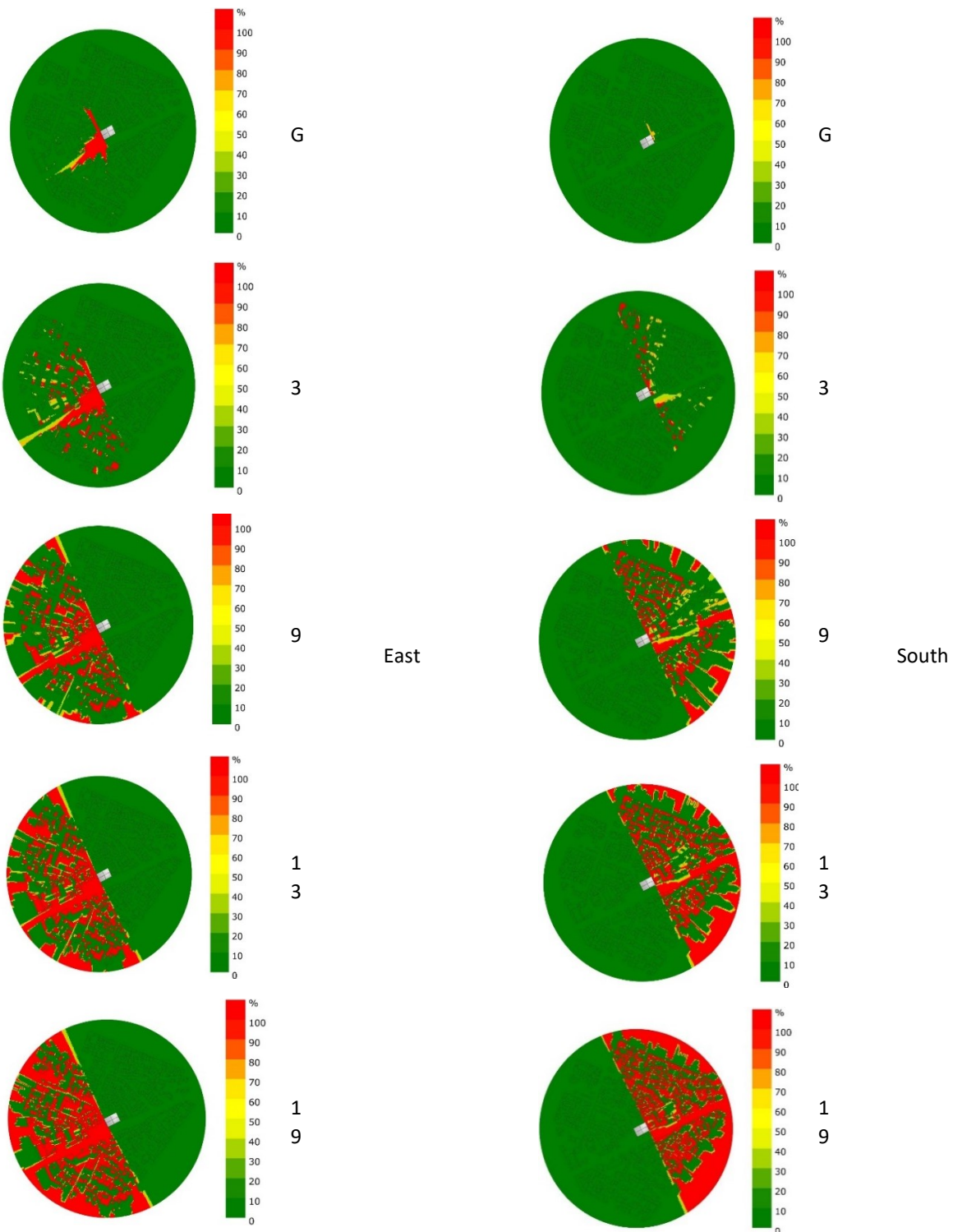
Figure 4. Sample points simulated on each floor in the Grace Hopper plugin

4. Results and discussion

In Table 2, the extent of the Alton Tower's dominance on the surrounding texture from four different views of the tower is analyzed through Grace Hopper software, along with the effect of increasing the number of floors on the surfaces under visual dominance around the Alton Tower in four directions (north, south, east, and west). It is necessary to explain that the results of the analysis are displayed to summarize the odd floors. As it is known, the visual dominance level of the tower in relation to the surrounding texture increases significantly with increasing the height of the upper floors of the tower.

Table 2. Examining the visual dominance of the Alton Tower on the surrounding texture in four different views

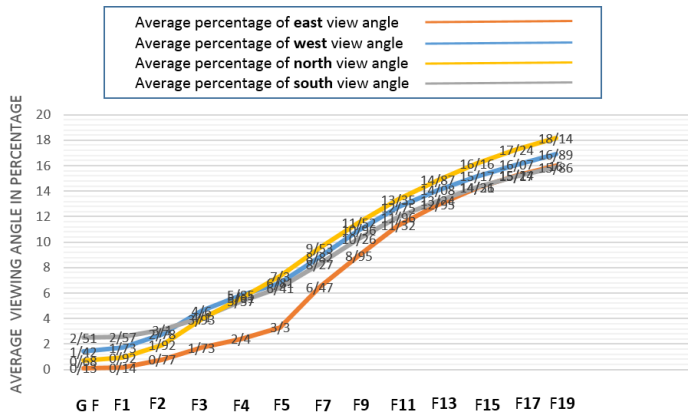
Dominance Analysis	Floor	View direction	Dominance Analysis	Floor	View direction
	G	South		G	North
	3			3	
	7			7	
	13			13	
	19			19	



Examining the models obtained from the Grace Hopper software analysis indicates the expansion of the surrounding surfaces that are under the visual dominance of the tower with increasing the number of floors in each of the four north, south,

east, and west views of the Alton Tower. The results of these analyses are presented in Figure 2.

Chart 2. The average percentage of the viewing angle of different views of the Alton Tower



The findings obtained from Grace Hopper software include the output images of the visual dominance of the Alton Tower on the surrounding texture on each floor and the average percentages of the viewing angle in four different views of the Alton Tower (Figure 1). Accordingly, the average percentage of the angle of view increases to the surrounding texture and more surface area of the surrounding neighborhood will be under visual dominance by moving from the lower to the higher floors of the Alton Tower in all four views of north, south, east, and west. Thus, the most important criteria of the Alton Tower, which affect its visual dominance on the surrounding texture, are listed in Table 3.

Table 3. Factors affecting the dominance of the Alton Tower

Components	Criteria	Alton Tower
Components related to high-rise buildings	Building form	<ul style="list-style-type: none"> Relatively simple form Lack of visual control barriers in the form of the building, especially in the upper floors
	Building height (viewing height)	<ul style="list-style-type: none"> The 75-meter height of the tower and complete control over the surrounding texture Relatively close residential area to the Alton Tower (increased visibility)
	Building facades	<ul style="list-style-type: none"> A combination of different materials in different parts of the facade The facade of the building is mostly made of glass, which increases the visibility of the surrounding spaces.
Components related to components around the high-rise building	Quality, type, and position of openings	<ul style="list-style-type: none"> The wide openings and windows of the tower are located on the upper floors with the parking land use, creating a complete and wide view of the surrounding texture.
	Land uses around the tower	<ul style="list-style-type: none"> Commercial land uses on the edge of the streets adjacent to the tower, such as the Daneshgah Street Residential land uses in other parts of the texture around the tower (more than 80% of the surrounding texture land uses)
	The location of the tower inside the texture	<ul style="list-style-type: none"> The location of the Alton Tower in the central part of the neighborhood (or the residential texture) and its complete physical and visual dominance
	The degree of compaction of the texture around the tower	<ul style="list-style-type: none"> A compact checked texture and often facing the tower (increased visibility) A compact and closed residential texture around the tower

- The degree of structural density of the texture
- High buildings, residential density, and apartments around the tower (up to seven floors)

5. Conclusion

The research results can be explained at two levels. The first level is to provide a practical method for examining and analyzing the extent of high-rise buildings' visual dominance over the surrounding texture. To analyze the subject of dominance, the research process was done in steps that can be generalized to other samples of studies. To provide a practical method for analyzing the visual dominance of high-rise buildings in a texture, applications such as GIS, Rhino, and Grace Hopper plug-in, can be used to gain a deep and broad understanding of the visual dominance of high-rise buildings. The process of this analysis is as follows. In the GIS software, the study area around the high-rise building was first determined based on the land use fields to obtain the height output of the three-dimensional texture building. Then, the resulting output was entered into Rhino software and the tower and its surrounding texture were modeled through the Grass Hopper plugin. In the next step, meshing the ground surface and the surfaces of the surrounding buildings were obtained in the prepared model to predict specific points for analyzing the viewing angle on different floors (or different heights) in the three-dimensional model of the tower. The results were used to analyze the amount of visual dominance.

The visual dominance of the research study sample, namely the Alton Tower, was specifically studied in the second level. The Alton Tower in Mashhad and its visual effects on the texture around this tower were studied as a study sample. In the neighborhood adjacent to the Alton Tower, about 85% of its parts are residential land uses and the surrounding texture is completely under the dominance of the tower in terms of visual dominance. It is completely weak in terms of providing privacy for residential buildings. Several solutions can be offered to reduce and control the visual dominance of the Alton Tower on the texture of the surrounding neighborhood. The first solution is to change the use of some blocks around this tower from the residential area to green space to create a distance between the Alton Tower and the

surrounding residential texture. This will minimize visual dominance by reducing the depth of human vision (100-300 meters) and increase privacy in surrounding residential land uses, including yards, apartments, etc. It is also possible to change the land use of some parts of the Alton Tower from residential to official and educational uses between the tower and the surrounding residential texture to increase privacy in the latter. The solution of creating a distance can be considered by locating a square or plaza in the space in front of the Alton Tower to block the direct view from the upper floors of the tower to the surrounding residential.

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