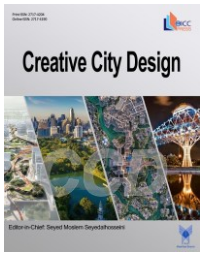

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Research Article

Evaluation of Building Density Criteria in Urban Development Plans Based on Development Capacities with an Emphasis on the Balance Between Social and Economic Components, a Case Study of District 9 of Mashhad City

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Abstract

Aims: This study aims to evaluate the physical dimension of construction, particularly Floor Area Ratio (FAR), in residential neighborhoods of Mashhad with an emphasis on sustainable development. The research seeks to identify how a balanced approach between economic and social development can be achieved in determining building density regulations within urban development plans.

Methodology: The research adopts a mixed-method approach combining qualitative and quantitative analyses. Data were collected through both library research and field studies. Field data collection included semi-structured interviews with urban planning experts and a structured questionnaire. Qualitative data were analyzed using Atlas.ti 7 software, while quantitative findings were statistically examined to assess the effectiveness of density-related policies. The Vakil Abad neighborhood in Mashhad was selected as the case study.

Finding: The findings indicate that despite policies aimed at increasing building density in Mashhad's urban development plans, spatial expansion of the city has continued alongside declining effective density. This pattern contradicts the principles of sustainable development, particularly in achieving balance between population distribution and residential land use. Furthermore, evaluation based on LUI standards reveals deficiencies in useful open spaces, leisure spaces, and parking facilities within the studied neighborhoods. The results suggest that sustainable neighborhood development indicators have not been adequately incorporated into FAR regulations.

Conclusion: The study concludes that current FAR regulations in Mashhad's urban development plans lack alignment with sustainable development principles. A more integrated and balanced framework considering social and economic capacities is necessary to ensure sustainable residential neighborhood development.

Keywords: Urban development plan; Floor Area Ratio (FAR); Sustainable neighborhood development; Building density regulations; Mashhad

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1. Introduction

Urban development plans are among the most important tools of city managers to control and guide the development process of complex urban environments. For this reason, the weakness in preparing such plans can make the management of sustainable urban development inefficient and ineffective. Urban development plans cover various topics. Topics such as determining urban land use, population distribution at the city level, forecasting required urban facilities and equipment, road network responsiveness to the intensity of traffic flows, and determining urban per capita and standards, etc. are among these topics. Determining and distributing building density is one of the strategic issues in the preparation of urban plans. The effort of urban planners is to be able to provide the basis for the balanced growth and development of cities by determining and distributing the building density optimally [1]. On the other hand, today, the increase in population and the emergence of new activities in the structure of cities have caused cities to grow, which often appears as growth from the periphery of cities, which has various complications, including; The loss of gardens and resources leads to high costs, wear and tear of internal tissues, loss of tissue cohesion, etc. This reveals the necessity of making an appropriate decision for endogenous development capacity. Building density as the ratio of building infrastructure (on all floors) to the area of residential land is an important issue in urban planning and land management. With the increase in population and large migrations to the city, it is possible to plan accurately to meet different needs. Employment, housing, education, health, etc. have decreased. As a result of the uncontrolled and uncontrolled expansion of cities, has caused great damage to the fabric of the city in terms of spatial cohesion and also the proper distribution of services. Considering the importance of preserving natural resources and Reducing the environmental effects of excessive development of cities, intermediate development has been proposed as one of the urban development approaches. As a result, instead of the horizontal expansion of cities, their growth within the existing limits and with the maximum use of developed land facilities located within the city limits is prioritized. Therefore, it is important to choose the right place to increase the density in cities [2]. Today, the problems and issues of the imbalance phenomenon in density not only overshadowed the urban planning policies, but its consequences have played a major role in aggravating the economic, social, political, managerial, and environmental problems of the societies. Here, the main issue is what factors increase urban density and create an imbalance in the economic and social sectors of cities, and what are the optimal urban density indicators? [11]

Based on this, in the current research, with the knowledge and knowledge of the multitude of factors influencing the determination of building density, due to the limitations of the research, only the socioeconomic criteria affecting this category were examined in the target neighborhood and with a threshold analysis, the maximum density It calculates a possible building for each neighborhood block based on the development capacity approach with a balanced approach between economic and social development. The objectives of this study are: to evaluate the criteria for determining density in urban development plans based on development capacities, emphasizing the balance between social and economic components. Investigating the balanced approach between economic and social development in determining building density

Providing solutions to modify the existing approach in determining building density based on development capacities, emphasizing the balance between social and economic components. In this regard, the research questions are:

What are the criteria for determining density in urban development plans based on development capacities with an emphasis on the balance between social and economic components?

What is the role of a balanced approach between economic and social development in determining building density?

What solutions are there to modify the existing approach in determining building density based on development capacities with an emphasis on the balance between social and economic components?

In this regard, we consider the following hypotheses:

It seems that the balanced approach between economic and social development has a significant relationship with the determination of building density. It seems that in Iran's urban development plans, the appropriate and scientific method for the distribution of urban density has not been used. The city of Mashhad, the second metropolis of Iran, has grown rapidly in recent years due to its natural population growth, immigration acceptance, expansion of services, country's construction plans, socioeconomic and political changes of the country, and finally the natural environment favorable for demographic and physical changes. He has seen a lot. The conversion of desirable agricultural lands into residential and industrial spaces, unplanned urban constructions, and the destruction of natural facilities and capabilities have endangered the urban environment and caused the balance between economic and social sectors to be disrupted. Therefore, considering the importance of building density and the problems it has caused in Mashhad, especially in the southwest area of the city.

This research seeks to evaluate the criteria for determining building density in Mashhad's urban development plans

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with a balanced approach between economic and social development in the ninth district of Mashhad and finally provide solutions to create a balance in these areas.

Examining global examples and experiences in the field of sustainable development studies shows attention to their multiple social, economic, cultural, and physical dimensions in all areas related to the city; Especially with the introduction of the idea of sustainable cities, achieving a balanced development that is related to changes in the physical fabric of the city has become doubly important. This is while the role of sustainable development dimensions in land use changes has been less addressed even in the far-reaching plans of Tabriz city. So that the centrality of these projects has been focused on the following three issues:

1. Urban Development Plans: Examining the special plans and the comprehensive plan of Tabriz city reflects the fact that there is a significant gap and difference between the current situation and the picture drawn in the urban development plans of Tabriz. Although this difference is to some extent a product of urban population growth, with all these other factors, such as the policies of the authorities in the direction and excessive expansion of population growth, it is clearly visible.

2. The set of transportation plans and expansion of communication network: Urban sprawl is a phenomenon based on transportation and physical characteristics of the communication network, which significantly affects the development and spread of population in the urban space.

Therefore, the current research, which emphasizes on the analysis and evaluation of the changes in the urban physical fabric in order to achieve the goals of sustainable development, is considered a new research in this field.

2. Background research

The issue of density is considered one of the key issues in the field of urban development and urban planning and design, and a lot of research has been done in this regard Table 1.

In this area, an attempt is made to briefly state the most important and relevant research to the subject under investigation.

3. Literature

Density at the city level, as a criterion for the establishment of population and urban facilities, is of particular importance in urban development plans. The choice of building density in urban plans has often been based on experiences and based on direct understanding, which ultimately leads to many problems and subsequent complications. The proposed building densities of many projects are faced with many problems during implementation and they are regularly faced with changes in the amount of proposed densities. The main reason for these issues can be seen as the lack of sufficient basic and scientific studies in the process of determining density. Building density is one of the most important issues of urban planning so density is mentioned in every work left in the field of urban planning.

Building density is equal to the ratio of the building infrastructure (on all floors) to the plot area.

4. Density

The number of areas (of each investigated element) in a space (or surface) is called the density of that element in that space or surface [3].

In general, the concept of density in the literature of urban planning in the framework of land use planning and under the category of zoning regulations, is an issue that deals with the distribution of spaces of elements, functions, and activities in urban areas. Density in urban design has a great effect on its function, form, and meaning. This effect is done by the amount of user activity in the functional dimension, the methods of controlling the volume, height, and distances of buildings, in the form dimension with the dimensions of function, and the semantic dimension and the artificial environment. accepted [4].

Density as a tool of urban development has an important and decisive role in the quality of urban form and landscape.

This form in urban design in general and the qualities of its implementation, in particular, is affected by the four factors of "scale", "density", "height" and "building mass", but the effects of building density are more noticeable in the physical dimension [18].

In the meantime, disturbance in physical spaces and urban form and landscape is one of the negative consequences of increasing building density.

Occupancy level, height, mass, and space are among the most important factors and physical issues resulting from decision-making regarding building density [5].

5. Advantages of density in different dimensions

Land reduction is the main motivation to seek more densities and it is not difficult to achieve. As the land decreases, the density increases, the largest land reserve is obtained with a relatively moderate increase in density. It is estimated that land is saved 10 times more by increasing the density from 4 to 24 inhabitants per hectare, compared to the increase from 160 to 220 per hectare [6].

Table 1. Source (author)

Year	Author Name	The title of the thesis/Thesis	Method used	Conclusion
2024	Abdrabo, K. I., Mabrouk, M., & Marzouk	Physical factors of urban land use changes in Lagos, Nigeria	The purpose of this research is to identify the influencing factors on the development of residential, commercial, and urban industrial lands during the years 1984 to 2000.	Based on this, land use changes have been analyzed according to satellite images and a model has been proposed to explain these changes using the logistic model. The results of the research show the need to control the use of urban land in order to minimize the environmental consequences of urban development.
2023	Zhao, P., Ali, Z. M., & Ahmad	Challenges of sustainable physical development in Lugas region	This research emphasizes the role of physical planning and government support for physical planning in achieving sustainable development	Based on the variables of sustainable physical development, after identifying the major challenges of sustainable development in Lugas region, it provides policies and solutions for sustainable physical development in this region.
2023	Khodakarami, L., Pourmanafi, S., Mokhtari, Z., Soffianian, A. R., & Lotfi, A	Physical system decision support approach in sustainable physical development	The focus of this study has been on determining the optimal locations for the physical development of the city, for this purpose, a framework of the existing urban land use status has been prepared and then based on that, solutions for sustainable physical development have been presented.	The results of the surveys show that in the development of cities, it is necessary to refocus on the built environments and stabilize them and create a balance between the natural and physical environment to achieve the goals of sustainable development.
2021	Asghari Zamani A Alizadeh S	valuating the reciprocal relationship between building lifespan and increased building density in Tabriz: Case study of Zaferanieh neighborhood	The study applied a descriptive–analytical research method using field surveys and statistical analysis. Quantitative data related to building age, land value, and construction density were collected and analyzed using correlation and regression techniques to examine the relationship between building lifespan and density increase.	he findings indicate a significant relationship between reduced building lifespan and increased construction density. Rising land value and redevelopment pressure contribute to higher density patterns. The study concludes that uncontrolled density growth may reduce urban sustainability and recommends implementing regulatory planning policies to balance density with urban quality and infrastructure capacity.
2019	Rahimi H Karimi H	Measuring urban sprawl using ANP model: Case study of Mashhad metropolis	This research used a quantitative spatial-analytical approach. The Analytic Network Process (ANP) model was applied to evaluate multiple indicators of urban sprawl, including land use change, population density, transportation accessibility, and physical expansion. GIS tools were used for spatial data analysis and mapping.	The results show that Mashhad has experienced significant urban sprawl characterized by low-density development and fragmented spatial patterns. The study emphasizes the importance of compact city policies and integrated urban management to reduce sprawl and improve sustainable urban growth.
2019	Marie-Pierre de Bellefon, Pierre-Philippe Combes, Gilles Duranton	Delineating urban areas using building density	Our analysis is conceptually simple. We first calculate the building density for each pixel as described above from the volume of all buildings connected to the pixel. The second step is to smooth the building density in pixels using a kernel. In the third step, we then generate the counterfactual building density by randomly redistributing the building into buildable pixels and smooth this counterfactual building density, just as we specify the real density for a line.	We have developed a new method for determining urban areas using detailed information about building location, which is based on a map of all buildings in France. Each pixel compares the actual dense approach of the building after smoothing the computed smooth and unrealistic structural density. Finally, we present new one- and two-sided tests that provide a statistical basis for comparing maps with different contours, which are used to assess the power of our approach and to document large differences between the preferred scheme and the corresponding authority.
2011	Meringev Mousavi	The sustainable form of the city and social justice(Case study: Miandoab city)	The research method is a descriptive analysis that uses statistical models such as correlation coefficient and linear, non-linear, logarithmic, inverse, and exponential regressions in SPSS computer software.	Establishing a statistical relationship between the density of service distribution shows that population density has a relatively significant relationship with the distribution of net z-score services of the population. In such a way that neighborhoods with very high population density have a completely unbalanced distribution of services. Therefore, the vulnerability of Miandoab's urban development was revealed by the criterion of service distribution (social justice). For this purpose, the optimal pattern of population density has been taken through a statistical test, which defines a population density of 250 people per hectare in each neighborhood as a model of sustainable urban development.
2016	Fatemeh Al-Haghli is of Neshli descent	he effect of building density on the stability of urban neighborhoods (case study: Babolsar city)	In this research, various statistical methods such as Smirnov, Kruskal-Wallis, binomial test, Spearman test, and Friedman test have been used.	The results of the research showed that there is a significant difference between the building density groups, and there is a difference between the stability in different parts of Babolsar city in terms of density the building density has been able to affect the stability of the neighborhood of the city. Also, the findings indicate that building density affects three dimensions of sustainability (physical, environmental, economic) in this city, but it has not affected one dimension (social-cultural). Babolsar is not in a very favorable situation.

6. Types of compression

Various definitions of density can be given. Measuring and expressing a global standard for measuring density is a difficult task due to its complex characteristics, the differences in its expression and use in different countries, and the differences in policies related to it. But the conventional method in this way is population density, which is determined based on the number of people living in a hectare [7]. In general, density in residential areas can be considered based on three different criteria, each of which has a specific application.

1. Population density refers to the number of people per unit area.
2. Residential density indicates the number of residential units per hectare (regardless of the size of the residential units).
3. Finally, building density is the ratio of the total area of the residential infrastructure on the floors to the total area of the site and indicates the amount of built area [8].

7. Total residential density

Overall residential density is a measurement tool used to measure the overall scale of a city. Therefore, by definition, the total residential density is the result of dividing the total population of the city by its built area. In this definition, the calculated area includes all lands with different careers. However, the above-mentioned two calculations, the area of undeveloped land and agriculture are not taken into account [9].

8. Net residential density

The number of people in the land related to housing is calculated in two ways. In Iran, usually, the number of people living on lands dedicated to residential use is considered. But in some definitions, the population refers to the entire residential sector, including residential lands, access alleys, and even several basic services such as kindergartens and daily sales [3].

9. Building density (infrastructure level factor)

Sub-building area factor (or building density) (FAR) measures the multiple or number of times the ground surface is equal to the building surface [5]. In fact, building density is the same as the floor area coefficient [10]. Surface of the building/surface of the ground = coefficient of the surface of the structure or surface of the structure = surface of the ground x coefficient of the surface of the structure [5].

10. Building density

Building density is one of the most important issues of urban planning so density is mentioned in every work left in the field of urban planning. Building density is equal to the ratio of the building infrastructure (on all floors) to the plot area. Building density is related to the concepts of ground level, building occupancy level, infrastructure level, infrastructure level coefficient, and open space coefficient [5].

In other words, the building density is the total area of the infrastructure in all the floors of the building divided by the total area of the plot of land and is calculated through the relationship {F=G.S/L}.

F is the building density, G is the area of the building on the ground floor, S is the number of floors and L is the total area of the plot of land. In this regard, the role of building density is evident as a basic indicator of the amount of infrastructure production. Increasing or decreasing building density in housing and building programs has a significant effect on the production of housing and building infrastructure [4].

Density in urban design also has a great effect on all three dimensions of the artificial environment, i.e. its function, form, and meaning.

This effect is through the amount of activity of users in the functional dimension and methods of controlling the volume of height and building distances; in the dimension of form through the dimensions of performance; And the semantic dimension and the artificial environment take place [7].

11. Building density dimensions

Building density, like population density, has profound effects in various economic, socio-cultural, environmental, and physical dimensions [3].

12. physical dimension

In the physical dimension, the effects of building density are more noticeable.

Disturbance in physical spaces and urban appearance is one of the negative consequences of increasing building density without thinking. Occupancy level, height and mass, and space are the most central factors and physical issues resulting from making decisions about building density.

Building typology, impact on the performance and quality of neighboring uses, access, and traffic network, view and landscape, form, organization, and spatial ossification of the city and walls are important physical issues [12].

13. Economic dimension

In the economic dimension, the effects of building density can be analyzed in terms of housing and building economics. The housing sector is one of the important economic sectors of society, which includes a significant share of the gross production. The amount of national investment in the housing sector, the amount of employment generated by the housing sector, and the share of production of construction materials in the macro economy are among the issues that show the importance of housing in the country's economy [13].

14. Social dimension

In the social and cultural dimension, the effects of building density can be considered. Increasing or decreasing building density regardless of the principles and criteria of urban development has caused social and cultural damages or fueled them [14]. Violation and sanctity of the rule of law, creation of a false right for owners and builders to demand additional density, issues of social justice, administrative corruption, overcrowding beyond the tolerable capacity of the environment, and as a result the intensification of social and political tensions are among the consequences that can be in As a result of such an action, accidents occur [15].

15. Environmental dimension

In the environmental dimension, it is expected that the urban development policies and plans take into account the correct direction of urban growth, expansion, and development. The theory of "tolerable capacity of the environment" can be considered the most basic principle in dealing with urban issues and in the form of sustainable urban development [3].

16. Building density in urban development plans

The main purpose of using the density tool in urban planning is to try to create a favorable environment for residents; In such a way that in those environmental conditions, on the one hand, a sense of desirability is created for them, which is dependent on meeting their various needs, and on the other hand, compatibility with environmental characteristics and capacities is provided [19]. Density is an objective and quantitative concept and can leave subjective and qualitative effects. The concentration level can be suitable to have positive mental and qualitative effects [16]. Therefore, the numerical density should be chosen in such a way that it is in harmony with the social and psychological characteristics of the people and their mental and behavioral patterns; Because in the end, people have to live at the level of urban neighborhoods; That is, in an environment that finds a specific physical pattern due to a specific density pattern. On the one hand, this physical pattern can be affected by the spatial characteristics and the mental and behavioral patterns of its residents, and on the other hand, it can affect the mental and behavioral patterns of the residents as well [17].

17. Methodology and case study

In this research, although a part of the issue related to methodological aspects has been stated in the first chapter, in this chapter, due to the necessity of further explaining and expanding the research method and drawing the conceptual model of the research, it is discussed separately. Therefore, this chapter is dedicated to the complete description of the research method, the method of collecting and processing information, and the models used in this research. The methodological process takes place in the six-layer Saunders onion model; Each layer is affected by the layer above. These layers are: 1- the research philosophy layer; 2- the research orientation layer; 3- the research method layer; 4- the research time frame layer; 5- The information gathering layer and 6- The information gathering tool.

The philosophical paradigm of this research is pragmatism. Because the most suitable philosophical paradigm for the mixed method is pragmatism or the originality of action school. In terms of its purpose, this research can be considered as an applied research; Because it seeks to operationalize the appropriate model obtained in connection with the case sample. The choice of research method has a close relationship with the goals and nature of the subject of research and its implementation possibilities. This research has been done to achieve a balanced approach between economic and social development in determining building density; This goal can be achieved with the help of the opinions of urban experts and experts in the field of urban planning and testing the variables of the research. Therefore, the research method in the present study is a combination of qualitative and quantitative content analysis studies as a mixed (combined) method of exploratory analysis of the type of compilation of classification to achieve the desired goal of the research. In the exploratory design used in this research, the goal of the two-stage exploratory design is that the results of the first (qualitative) method lead to the formation and clarification of the second (quantitative) method. The discovery of the phenomenon is the final model of research. Therefore, in this research, the variables

are unknown (although the theoretical framework is extracted from the theoretical foundations, it cannot be relied on in the local context due to the specific social and economic characteristics), and important variables must be identified to conduct the research quantitatively. Therefore, the qualitative stage is used as the basis for creating a tool, identifying the variables, or describing the necessary cases to benchmark the knowledge framework. Since this project starts qualitatively, qualitative data is emphasized more.

According to the stages of research implementation, data collection will be as follows in each stage:

1- In the first stage; Studying the current state of the physical fabric of Tabriz city with an emphasis on land use; Through the examination of GIS maps, it is obtained that the amount of changes in each of the regions in a period of 10 years is inferred based on the maps.

2- Sustainability indicators suitable for Tabriz city will be extracted based on document study through reviewing reliable sources and references in this field, and then using AHP and Delphi techniques, appropriate indicators will be categorized and selected.

3- The necessary data for comparative comparison between different regions is obtained in GIS through GIS maps and by entering the weight obtained for each of the indicators in the previous step.

4- Based on the results obtained from the 3rd stage, the model of urban development is proposed according to the sustainability indicators.

Obviously, during the research, additional methods will be used to complete the research steps.

Data analysis tools can be divided into two categories based on the type of data collected:

1- The analysis of documentary data is achieved through their theoretical examination and their summarization.

2- Analysis of maps in GIS software and analysis of stability indicators will be done using AHP technique Figure 1.

18. Socio-cultural studies population

According to the statistics published in the statistical yearbook of Mashhad 2018, Mashhad's No. 9 district covers an area of 2144 hectares, 6.24% of the area of Mashhad city. While in terms of population, it occupies more than 10% of the city's population (according to the population and housing census in 2015).

Examining the evolution of the region's population share during the years 2006 to 2016 shows the trend of increasing its share. The population share of this region increased from 2006 to 2016 from 10.4% to 10.7%.

Also, the comparison of the population density of the Noh area with the city of Mashhad also shows the high population density in this region, at the level of the metropolitan area, this indicator is 152 people per hectare, while this amount in the city of Mashhad is 89 people per hectare. It is a hectare. All these figures Table 2 show the importance and location of the area in Mashhad.

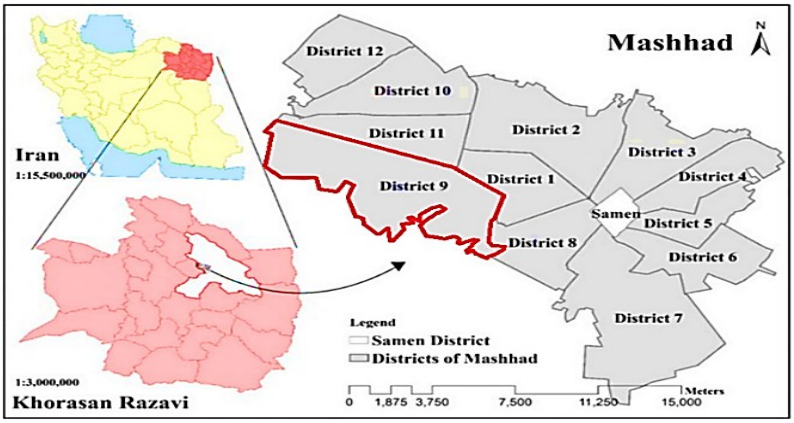

Figure 1. The location of area nine in Mashhad city

Table 2. www.amar.org.ir

2016			2006			Description
percent of the city	Region 9	Mashhad city	percent of the city	Region 9	Mashhad city	
10.8%	165125	1527439	10.6%	127708	1203478	Women
10.5%	161876	1534803	10.2%	124822	1223838	Men
10.7%	327001	3062242	10.4%	252530	2427316	The whole population
11.1%	103077	931341	10.5%	67177	637427	Household
-	3.17	3.29	-	3.76	3.81	Family size

19. Examining housing demand according to existing social and cultural conditions

The type of housing needs and behaviors of different social strata of residents in any area require special housing to the social conditions and cultural tastes of its residents, and the functional spaces of the housing take on different dimensions according to the mentioned conditions. The basic elements of housing such as security, desirability and compliance, and the financial ability of households are placed at the top of the criteria related to social needs. The cultural dimension of housing should also be considered as one of the important issues in the housing sector.

Based on the assessment of the social structure and its stratification, which was done in the social and economic discussions of the domain, the social layers of the domain are divided into four groups based on the main occupational groups, and each group is divided into several layers. Considering the capabilities and needs of each of these groups, it is obvious that these strata are among those sections of society that urban modernization penetrates deeply into their lives and their social-spatial demands can be considered completely modern.

20. Economic studies land price

The most important examples of determining the price of land and residential buildings in the 9th region can be listed as follows:

The amount of supply of land and residential units for purchase, sale, and rent in different parts of the area.

The amount of land and housing suppliers' need for buying, selling, and renting the income resulting from the exchange of the ability of land and housing applicants to pay for buying, selling, and renting it. The extent of the expectations of its suppliers and applicants from the current price changes in the future, the ease of access to land and housing to the communication network of the required urban services, and... the status of ownership (a waqf person with a document or without a document, etc.) of the land and housing, settlement position in the field of social status and place acceptability of land and housing to be exchanged. The size of the price of the land and infrastructure of the residential unit and its suitability to the buyer's needs.

21. Movement and accessibility studies

The main first-class arterial routes in the 9th region, according to the definitions in the Urban Roads Design Code, include the following streets.

-Vakil Abad Boulevard, Mashhad City: this boulevard is very wide, and with optimal use of this width, the Mashhad city train was built in its geometric middle. The western end of this boulevard leads to the range and heights of Binaloud. The eastern end of this boulevard is connected to Malakabad Boulevard (martyr Ayatollah Ashrafi Esfahani) after passing the Azadi highway. The eastern part of this highway ends at Azadi Square, And it is connected to the eastern part of the Imam Ali Highway through Azadi Highway.

- Another first-class arterial axis is the southern axis, which is along Hasht Shahrivar Blvd.

- The main secondary arterial routes in the 9th region include the following streets according to the definitions contained in the by-laws for the design of urban roads. These city passages, one or both of their ends are connected to a first class arterial passage.

-Victory Boulevard, which is very important. This boulevard covers the entire western-eastern area of nine municipalities. This main secondary artery is limited to the Sedav Sima Square from the east, while in the west it reaches the designed and half-implemented beltway of Shahid Bronsi and even crosses it.

- Hasht Shahrivar Boulevard: currently it covers the region in the form of an arc (similar to the third quarter of a trigonometric circle) from the west to the south; Along its east side, it takes the name of Shahid Fakuri Boulevard. This boulevard is also considered one of the main second-grade arterial streets in the region. The north-south section of this boulevard in the new detailed plan, with the continuation of the route as a ring road, limits the south of the 9th area.

- Iqbal Street Lahori, street leans on Vakil Abad highway from the north.

- Heftam Tir Boulevard (water and electricity boulevard): This boulevard relies on the Vakilabad highway from the north and connects to Hasht Shahrivar Street or the boulevard from the south.

- Hashemiye Boulevard: It leads to Vakil Abad highway from the north. The southern end of this boulevard has been extended to Pirozi Boulevard and it is by the detailed plan of the south of the Asian highway, which is the detailed supplementary plan of Khazni so that the belt will go forward.

22. Functional studies

This region with an area of 4010 hectares, this region with an area of 2732 hectares, a relative share of 68%, and gross urban lands with an area of 1277 hectares and a relative share of 31%. The net urban land of the region includes residential uses with an area of 1063 hectares and a relative share of 39%, service uses with an area of 680 hectares and a relative share of 31%, and a communication network with an area of 808 hectares and a relative share of 29%.

In this area, the presence of higher education centers of Ferdowsi University of Mashhad and the University of Medical Sciences along with some other major uses such as police land, warehouse of Khorasan Regional Electricity Company, Pars Hotel, Mithaq Hotel, etc. It has been used for services that if the levels of these uses are reduced from the service uses of the region, the number of services in this area will be greatly reduced and requires serious planning in this field (Engineer Masawar Naqsh Piravush, 2018).

23. Physical-spatial studies

23.1. Divisions of customary localities

In the area of No. 9 Mashhad, it is difficult to assign completely distinct characteristics and identities to different residential areas. Of course, Ne Dara and Vakil Abad (Vail Castle) are exceptions due to their distinctive structure and texture. These areas are completely recognizable due to having a semi-organic structure with low physical quality and a different social image from other residential structures in the area. The steep slope of the narrow alleys of the Nah Dareh area, which contrasts with the relatively flat areas of other residential structures in the area, has given it a completely distinctive face. The only difference between the localities of the region is not because of its topography, but also because of its proximity to the southern elevations Figure 2.

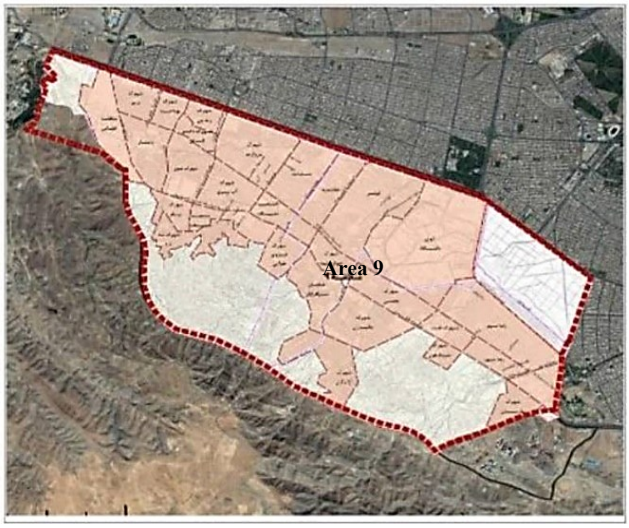

Figure 2. Customary neighborhood classification in the 9th district of Mashhad

23.2. Promotion system

In area night, the height of the buildings is mainly between 1 and 4 floors. The height system of the range is uniform and the height accumulation has little relation with the spatial structure of the range and the density of activities.

As can be seen in the map, there is no noticeable change in the height system of the buildings around the active and main axes such as the Vakil Abad axis. High-rise buildings have been built or are being built in a scattered manner and without regard to the bed and background.

24. Analyze

24.1. Characteristics of urban uses

According to the latest area of Mashhad city, out of the total area of about 25230.7 hectares, a surface equal to 7177.1 hectares or 28.45% of the area was unbuilt and barren in 2015, and the rest of the area has urban use, and urban areas. is considered A considerable part of vacant land is located in areas 7, 8 and 9. In this way, of the total area of the city, the surface area of about 18054.7 hectares, equivalent to 71.55%, constitutes the built-up area of the city.

- To understand how the lands of Mashhad are used, I will divide the uses of the city into 5 groups as follows:
- Residential use including housing and residential complexes;
- Use of services including all welfare and infrastructure services and green and recreational spaces;
- The network of roads including the network of main roads and highways up to the level of local access;
- Special use including agricultural, military, livestock, and miscellaneous lands;
- Barren and unbuilt, which includes barren lands and abandoned and ruined structures.

25. Findings and results of the questionnaire

Before addressing the results of the questionnaires related to the level of education, length of stay, factors of neighborhood identity, and belonging to a studied neighborhood, statistics and general information from the questionnaires are presented here. The results of the questionnaires show that regarding the level of education of the respondents, more than 34% of the people in the Pirozi neighborhood had a diploma, while in the Vakilabad neighborhood, more than 37% of these people had a bachelor's degree or higher. which indicates the high social status of people living in Vakil Abad. Important results were obtained regarding the length of stay of the residents, while more than 43% of Piroziresidents had lived in the neighborhood for more than thirty years. In the Vakilabad neighborhood, more than 60% of the residents have lived in this neighborhood for less than ten years. This shows thatin Table 3 the Vakil Abad neighborhood is newly built compared to Pirozi.

Table 3. Analysis of some principles of sustainability in Vakilabad neighborhood,(Author,2024)

titles					
Level of education of the respondents	illiterate	Cycle	diploma	Associate Degree	Bachelor's degree and higher
	11.1	9.3	37	5.6	37
The length of stay of the respondents in the neighborhood	Less than 10 Year	Between 10-20 _ Year	Between 20-30 _ Year	More than 30 Year	
	63	18.5	16.7	1.9	
The main factors of neighborhood identity according to the respondents	urban planning	Social relations governing the neighborhood	Park and urban green spaces	other	
	14.8	51.9	27.3	6.5	
The factors of residents' belonging to the neighborhood from the respondents' point of view	being old	Square and green spaces of the neighborhood	Residents and neighbors	shopping center	other
	25.9	27.8	29.6	3.7	12.9
The reason for choosing the neighborhood to live in from the respondents' point of view	Comfort and peace	neighborhood identity	Reasonable housing price	Proximity to work	other
	61.1	14.8	0	13	11.1
The place to spend leisure time from the point of view of the respondents	home	Squares inside the neighborhood	City parks	Nature and spaces outside the city	other
	25.9	9.3	31.5	18.5	14.8

26. Discuss

The main purpose of this research was to investigate and evaluate the physical dimension of construction (FAR) in residential neighborhoods with the perspective of sustainable development in Mashhad, and the Vakil Abad neighborhood was chosen as a sample. To do this, first, the position of density in the schools of urban planning was examined: in this regard, to prepare the theoretical framework of the Chicago schools, modernism, postmodernism, cultural orientation, sustainable development, etc. were examined. Emphasis on high-rise construction and the use of new technologies for high-rise residential buildings and dense development close to each other and on the side of the street, the common denominator of Chicago schools, technocracy, and modernism. Revival of old cities and reducing their density for habitation and emphasis on asymmetry and disorder in cities as well as living in nature and village-like environments from the common principles of schools of naturalism, culturalism, and humanism and emphasis on organizing part of cities instead of The whole of it is giving importance to mixing uses, encouraging walking and relative control of cars in the urban space, and emphasizing low-rise buildings in the school of postmodern urbanism. With the emergence of the sustainable development paradigm and school, the most important urban challenge has been the relationship between the urban form and its sustainable development.

In this school, while criticizing the sprawling city form due to the insatiable use of land, non-stop, uniform, and discontinuous development, low density and dependence on personal cars, and... on the development of the compact city form as a strategy for Reduction of urban problems is emphasized. Orientation in high density, mixed and intensive use of urban form, emphasis on better access to urban facilities and facilities such as public transportation, walking and cycling and more and effective use of them and provision of infrastructure, emphasis on Local community or neighborhood, unlike conventional models of urban planning, also emphasizing human-centered elements in cities to access better quality of life and paying attention to neighborhood environmental conditions are key components in compact city planning. Emphasis on

these components in many new patterns of development such as; Transportation Oriented Development (TOD) (emphasis on public transportation, more building and population density, placement of diverse uses next to each other and cluster residential use and close to each other), planned units or PUD (design of denser residential complexes) considering more public open and green space), Smart Growth (mixed-use, higher density and compactness of urban centers, emphasis on public transportation and pedestrian-oriented activities) and New Urbanism (more density, transport, and green transfer, mixed-use, environmental sustainability and emphasis on the traditional structure of urban neighborhoods) can also be seen. In general, the common denominator of most of these theories is the emphasis on increasing density in cities to reduce the negative effects of scattered cities.

Considering that the increase in density in the cities of the country is related to the increase in the physical dimensions of buildings.

The physical dimension of the building and its physical effects on the urban form and landscape and its place in the country's urban development plans were further analyzed. Substructure area coefficient, occupation area coefficient, pattern and level of separate parts, building height or floors, building mass and volume, and residential unit per hectare are some of the main methods that are used to control density in cities.

Sustainable neighborhood development indicators have not been taken into account in the preparation of urban development plans and the formulation of rules and regulations related to FAR in the residential neighborhoods of Mashhad.

Based on the theoretical framework of the research, the main principles, criteria, and characteristics of physically sustainable urban neighborhoods were extracted and expressed in new theories and ideas of urban planning such as compact city, PUD, TOD, smart growth new urbanism, etc. Increasing the density in the neighborhood up to 4 floors, mixing urban uses, walking access to neighborhood uses and reuse of urban lands, access to more open and green spaces in the city neighborhoods, and... are among the main indicators. Sustainable development is at the neighborhood scale.

About these indicators, the urban development plans of Mashhad and the rules and regulations related to the physical aspect of its construction were examined and analyzed. As mentioned, two comprehensive plans and two detailed plans have been prepared and approved for the city of Mashhad.

In this research, Investigations show that these indicators have not been properly considered in any of the mentioned plans. However, in the first comprehensive plan of the city, the emphasis was on the protection of the gardens within the boundaries and the emphasis on the optimization of the density, and the recommendation of a continuous and dense model for the development of the city, which is somewhat in harmony with the views of today's compact city and the attitude of sustainable development. The low physical dimensions of Mashhad city and the studied neighborhoods (two floors and even less) in the plans and residential areas built within the scope of the first comprehensive and detailed plan of the city, including the Vakil Abad neighborhood and ignoring other indicators The mentioned sustainable development of a neighborhood in its related plans, rules, and maps is one of the main shortcomings of the first comprehensive and detailed plan of Mashhad city about the sustainable development of a neighborhood.

Examining the studied neighborhoods as an example also shows that these indicators have not been taken into consideration in the preparation of urban development plans and the formulation of rules and regulations related to FAR in the residential neighborhoods of Mashhad. In this way, we can understand the truth of the first hypothesis of the treatise.

The increase of FAR in the residential neighborhoods of the city was not based on the approved urban development plans and urban planning approvals.

To test this hypothesis, two major arguments have been raised:

A- Instability of FAR-related rules and regulations:

Reviewing the rules and regulations of Mashhad city development plans in different periods shows that there have been many changes in the rules and regulations related to the physical aspect of construction in the past approved plans. For example, the maximum occupied area (LA) has reached 60% in the second comprehensive and detailed plan from 50% of the plot area in the first master plan of the city. In the discussion of open space (OS), the reduction of open space from 55 square meters for each residential unit to 30 square meters by the governor after 2015 and increased to 10 square meters during the construction of 2015 to 2015 by the Islamic Council of Mashhad And the approval of 15 square meters in a worn-out structure and 20 square meters in other parts of the city by the Supreme Council of Urban Planning and Architecture in 1401 is a part of these changes. In the latest approved detailed plan, the proposed density zoning has been completely abandoned.

The directives and approvals of the Article 5 Commission have made decisive changes to the detailed plan and in many cases have called into question the basis of the comprehensive plan.

Repeated approvals have caused unwanted physical changes in neighborhoods and affected the construction of urban structures.

B- The city's dependence on the revenues from the increase in FAR:

As it was said in the sale of density, after the government's approval to separate the municipal budget from the government budget, the sale of density became the main source of revenue for the municipality to provide current budgets. However, in the early 70s, this was temporary and after many discussions that criticized the sale of density. It was stopped, but a look at the approvals of the city council regarding increasing the physical dimensions of construction and making the city of Mashhad dependent on the revenues from it shows the income view of the sale of density in the form of increasing the physical dimensions of the basic building to the permitted one. The approval of the 7P resolution of the Islamic Council of Mashhad in the early 80s and its persistence until today has practically opened the way for any purchase and increase of FAR by the builders of residential units and has made it impossible to realize the density of the proposed plans of the approved city.

The construction of residential units, especially the issue of increasing the physical dimension of the building, is not based on urban development plans, but based on density criteria approved by the Islamic City Council. The investigation of the studied neighborhoods shows that most of the built residential parts do not comply with many of the parameters of the FAR-approved rules, such as the need to comply with open space, parking, the width of the side passage, etc. Part of the rules and regulations of the physical aspect of the building, which after going through the long processes of preparing and approving stages, should be used as a criterion of action in the construction, is not considered in the construction stages. In many recent constructions in the studied neighborhoods, at least one extra floor has been built. For example, during the years 1402-1395, out of a total of 118 residential blocks built in the Vakilabad neighborhood, about 41 floors were built more than the approved criteria of the last detailed plan. Construction violations are a constant part of construction in Mashhad city, so there are about 16 thousand cases in the Mashhad Municipality Article 100 Commission, where a large part of the cases are related to violations of residential buildings. There is. Therefore, according to the mentioned points, there is not much conformity between what is made and what is given in the rules. Therefore, the correctness of this hypothesis is also confirmed.

27. Conclusion

Demographic developments, in almost all the cities of the world, are towards the increase of low-density households of two to three people. Therefore, the construction of low-area residential units in residential complexes has a growing trend in the direction of increasing the physical dimension of construction and residence. This trend is aggravated by the general phenomenon of increasing land prices in cities. Therefore, increasing density is a natural and inevitable evolution of future cities.

With the introduction of the perspective of sustainable development and intensive urban growth, perhaps the main means of realizing this is increasing the physical dimension of the building or infrastructure level (FAR). The main goal of increasing the physical dimension of the building is not to increase the density and size of the population, but the main goal is to allocate more land to open and green space by using the patterns of high-rise residential apartments. However, if this increase leads to an increase in population in some areas, it is not necessarily negative, but it may be necessary for the optimal use of land.

The state of the physical dimension of construction in our country shows that most of the cities of Iran had less physical dimension of construction until a decade ago, and even today, although the physical dimension of construction has increased in the last years in the cities of the country, especially the metropolises, this ratio is still low. The main reason for this can be found in the formation of scattered urban development, planning and design of lands with low density, the performance of government organizations such as urban land, housing cooperatives, the assignment of land by various institutions, as well as the performance of the private sector and the desire to have Searched for separate and independent residential units. The fact is that we have not made optimal use of our space, land, and natural resources. Most of our cities have large areas and low density. As a result, the agricultural lands on the outskirts of small and big cities are in danger of destruction, therefore, the optimal use of the existing lands in the area of the city of Hazrovi is necessary.

Surveys show that despite the policies that have been taken in the urban plans of Mashhad, including the policy of increasing the physical dimensions of buildings, the city continues to face a decrease in density with the increase in area. is And this is in conflict with the principle of sustainable development in the balanced development of the population and the residential area of the city in the lands around the cities. It should be noted that the major part of this increase is related to the area of residential settlements around the city of Mashhad, such as Khavaran, Marzdaran, etc., which are only intended for residential construction.

The result of the FAR status of the studied neighborhoods based on the ratio of open space to infrastructure and the current road network shows that the maximum optimal FAR for Pirouz neighborhood is 4 floors and for Vakil Abad neighborhood is 5 floors. Obviously, if this amount is observed, it is possible to provide open space in these

neighborhoods based on the approved criteria of the detailed plan.
And there will be no problem in terms of the number of building floors by observing the network of side streets. This is confirmed by the LUI or land use intensity model and is consistent with the proposed compact city density as a sustainable development model for future cities, which suggests a maximum 4-story building dimension. In addition, it is compatible with the wishes of the residents of the studied neighborhoods, which more than 60% in Vakil Abad neighborhood and 70% in Pirouzi neighborhood, who consider the maximum physical dimension of their optimal building to be 4 floors. Therefore, it is necessary to consider these results as a principle for deciding on the optimal physical dimension of the studied neighborhoods.
This should be the case for other urban neighborhoods as well.
Considering the issues tested in the research hypotheses, it is necessary to consider sustainable urban and especially neighborhood development indicators before any increase in the physical dimension of the building. And the increase in density depends on the observance of the physical and social indicators of sustainable development at the neighborhood and urban scale.
Secondly, the increase in the physical dimension of the building should be based on the approvals and criteria of the development plans. Because in case of non-compliance with these rules, the basis of preparation of urban plans and its rules lose their legal validity.
Thirdly, the increase in the physical dimensions of buildings in neighborhoods and urban areas is subject to measuring the intensity of their land use and should be used to determine the FAR size of the comprehensive LUI system as a basis for controlling density dimensions. In this system, some important components in increasing the physical dimensions of buildings such as open space (OS), useful open space (LS) and recreational space (RS) per square foot of land surface (LA) as well as the minimum number of parking spaces for Occupants (OC) and the total number of parking spaces for each residential unit (TC) are given, and by specifying urban residential units in the form of three main groups of single-family residential units, apartments without elevators and high-rise apartments with elevators, criteria and intensity numbers for each group Land use is specified.
In addition to this, the limits of intensity of land use have been mentioned for each type of building. which have been proven as the most favorable values for that type of construction. The use of this method in the analysis of the physical dimension of the construction of the studied neighborhoods has proven the efficiency and possibility of using this method in the urban neighborhoods of the country, and it can help the stability of residential neighborhoods and provide a very important guide for planners and decision makers regarding provide the physical dimension of the building (FAR).

28. Offers

28.1. On a city scale

One of the techniques used to control FAR is the comprehensive system of "Land Use Intensity Measurement" or LUI for short. Therefore, as an important principle, it is suggested that the LUI method be used as a basic system to control congestion in Mashhad and its residential neighborhoods.
To reach the desired range of LUI in the city and its residential neighborhoods, some ratios related to its parameters can be adjusted or increased. In addition to this method, the preparation of the native model of the Spacemate diagram based on the city planning rules and regulations of the city of Mashhad can lead to the organization of the physical dimension of the city's construction.
- Creation of expert boards and opportunities for planners and decision-makers to create rules and regulations related to density, taking into account citizens' rights and indicators of sustainable urban and neighborhood development.
- Approving strict regulations regarding small plots of land and emphasizing the consolidation of these plots before increasing the physical dimensions of the building
- Preparing and compiling a scientific and practical framework for the concept of density to better understand the concepts related to it, including the open spaces of buildings, the number of floors and height, the location of parts, the shape of buildings and courtyards about buildings, etc.

28.2. At the neighborhood scale

Increasing density and compression, although it is considered a requirement for sustainable development, the use of this solution should be done by considering all-natural potentials, road network, physical characteristics of parts and open space, etc.
- Preparing a three-dimensional map of the city, at least in the residential neighborhoods, and measuring its effects on the physical structure of the city before it is realized and facing the problems related to it.
- Increasing the physical dimension of construction based on infrastructures, road networks, water supply networks, electricity networks, gas supply networks, and sewage networks in the current and future situation.

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Authors Contribution

Neda Dadkhah contributed to the conceptualization of the study, data collection, analysis, and drafting of the manuscript. Seyed Moslem Seyed Al-Hosseini supervised the research process, contributed to the research design and methodology development, and critically revised the manuscript. Maryam Daneshvar contributed to data interpretation, validation of results, and manuscript editing. All authors read and approved the final manuscript.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interests

The author states that there is no conflict of interest.

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