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Morphological Transformations of Isfahan's Historic Core: Impacts on Urban Fabric and Sustainability

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Abstract

The shape of cities has changed at an unprecedented rate in recent years, with primarily adverse effects on the traditional contexts of historic city centers. The spread of new urban forms has led to the neglect of key features in traditional urban planning. Increasingly, old structures are being demolished rather than restored or updated, vernacular patterns are being lost, and the development of physical and functional spaces (shaped by centuries of economic and social relationships through trial and error) has been overlooked. This has resulted in the disappearance of values that once influenced the urban fabric, creating undefined and shapeless spaces. This research aims to address the question of how and based on what criteria the urban areas of Jamaleh can be evaluated to develop a more sustainable model, and what methods can be used to quantify these criteria. Through a review of the literature, the authors identified the criteria for evaluating urban areas in terms of shape and morphology, environmental, visual, movement, and access dimensions. Given the qualitative nature of some expectations for urban plots or blocks, the evaluation method for each criterion is also provided to quantify these qualities. Based on this evaluation, urban properties in four blocks of the Jamaleh neighborhood in Isfahan, in 1976 and 2003, were compared according to the established criteria. Finally, the research findings indicated that the Jamaleh neighborhood is losing its qualities in terms of form, environmental, and visual criteria, while gaining points only in terms of movement and accessibility.

Keywords

Morphology, Evaluation, Blocks and Urban Plots, Isfahan Historic Core, Sustainability

1. Introduction

To better understand the pattern of city plots, it is essential to consider their historical transformation. In identifying these patterns, two types of spaces emerge: traditional and modern. The traditional areas of Iranian cities typically feature an integrated urban context, where the central courtyard element is a key characteristic. In contrast, modern urban spaces are primarily composed of isolated buildings set in shapeless open areas, with grid-like street networks. The physical structure of traditional Iranian urbanism has endowed the city context with qualities such as enclosure, privacy, inward orientation, human scale, plot proportion, a connection with nature, and better alignment with the climate. These qualities have diminished with the shift from traditional courtyard-based patterns to modern ones, particularly the prevalent 40 - 60 model. Traditionalists have criticized the modern pattern, advocating for the preservation of the conventional one. This study seeks to present a logical and systematic method for evaluating these patterns, so that, based on specific criteria, different urban designs can be assessed.

The main question of this study focuses on how city plots in the Jamaleh neighborhood can be evaluated, independent of any specific bias towards traditional or modern patterns, in order to develop a more sustainable urban model. The study also explores which criteria can be defined for this evaluation and how they will be explained. While acknowledging that the criteria presented are not exhaustive and could be expanded through similar research, this study aims to propose a comprehensive evaluation method. Criteria were initially extracted from scholarly texts, and a method for identifying a more sustainable urban pattern was defined. To clarify the evaluation process, these criteria were categorized into four groups. The study also attempts to predict how the qualities of the urban plots will be assessed and quantified, drawing on established methods in this field.

Based on the six main aspects of urban design introduced by Carmona et al. (2008), the evaluation criteria were reviewed according to the research goals and objectives and organized into four categories: morphological, ecological, visual, and functional (movement/access) dimensions. Carmona emphasizes that urban design is an integrated field of knowledge, and these classifications are used solely for clarification purposes in presenting and analyzing content. The categorization is not intended to draw strict boundaries between the sections but to clarify the scope and relevance of each topic.

The Jamaleh neighborhood, located in the historic core of Isfahan City and characterized by a traditional urban pattern, was selected as a case study. This selection was made to address how the defined criteria can be applied and to answer the stated questions. The neighborhood has undergone a transformation from a traditional to a modern urban context. In this study, four blocks (2, 3, 7, and 9) that have experienced the most significant changes were selected for detailed analysis. A literature review was conducted to discuss the relevant theoretical principles related to morphology, employing a descriptive-analytical method based on the morphological study of the Jamaleh neighborhood and a comparative

analysis of its context over two periods. The study defined criteria for evaluating city plots to identify a more sustainable urban pattern. For this purpose, the existing characteristics of the traditional urban fabric in the Jamaleh neighborhood were used as a reference. The research findings indicate that, according to the evaluation criteria, the Jamaleh neighborhood has lost its original qualities in comparison to its previous urban context.

2. Literature Review

The morphology of cities is often studied in relation to their shape and form. According to the Architecture and Urbanism Encyclopedia, morphology can be defined as a measurable quantity that encompasses both two-dimensional and three-dimensional space, characterized by an objective structure. This definition takes into account the dimensions and orientations determined by the configuration of urban plots. Carmona, citing Conzen, identifies several key elements of morphology, including land use, building structure, plot pattern and street pattern. He notes that these elements vary in sustainability, with networks being among the most permanent urban components, considered valuable assets. In contrast, blocks have a persistent division pattern but may be combined or divided, while building usage is more transient and subject to rapid change (Carmona et al., 2008: p. 118).

The study of morphology in Germany has been influenced by Conzen's ideas, particularly his four-part division of urban form: land use, building structure, plot pattern and street pattern. Research following Conzen's work on urban form has built upon his influential studies. Since the mid-20th century, various approaches to city shape have emerged. Owen categorizes these studies into three areas:

- Environmental and behavioral studies, which focus on the two-way relationship between human behavior and urban form;

- Studies on location and image, which examine perceptions and mental associations related to urban form;

- Structural and process-related studies, which analyze the evolving built environment through the elements classified in urban form (Owen, 2005: p. 64).

This study explores the evolution of built environments through systematic analysis. Moudon (1997) identifies three schools of thought in the study of urban morphology. The English Morphology school focuses on the descriptive study of city form to develop theories of urban construction. The Italian Morphology school emphasizes analyzing city form to propose urban design strategies. Lastly, the French Morphology school examines the impact of past urban design theories on urban structure.

Table 1 highlights the contributions of various researchers to the study of city shape and morphology. Building on these studies, this research focuses on the morphological analysis of the Jamaleh neighborhood, specifically investigating its changes over time. Furthermore, consistent with Rob Krier's work, the geometric properties of the neighborhood's urban plots were also analyzed.

Table 1. Key concepts and research findings in the field of morphology.

Muratori	1950	Classification of typology into three stages: location selection, typology scale, and typology process (Memarian & Brown, 2003).
Conzen	1960	Division of urban form into land use, building structure, plot pattern and street pattern (Carmona et al., 2008).
Lynch	1960	Defines the five key elements of city form as paths, edges, districts, nodes, and landmarks (Lynch, 1960).
Rossi	1982	Revised the ideas related to "architectural typology" through his book The Architecture of the City (Carmona et al., 2008).
Caniggia	1984	Understanding the form of the built environment through examining the historical process of its formation (Mirmoghtadaei, 2015).
Bill Hillier	1985	Defining the city's morphology as a physical form and its relationship with social forces (Carmona et al., 2008).
Rob Krier	1979	Categorized urban spaces based on their shapes, focusing on geometric analysis, and critiqued modern urban spaces (Krier, 1979).
Colin Rowe	1944	Evaluation of the urban space design about the city's development according to its historic structure and the traditional typology of the urban space (Carmona et al., 2008).
Kropf	1966	Building on the work of Conzen and Caniggia, he studies urban tissue and its components (Mirmoghtadaei, 2015).
Owen	2005	Divided city form studies into three categories: environmental and behavioral studies, studies related to place, and studies focused on structure and process (Owen, 2005).

3. Research Methodology

To illustrate how the defined criteria were applied and to address the stated questions, the Jamaleh neighborhood, located in the historic core of Isfahan City and characterized by a traditional urban pattern, was selected for this study. This neighborhood was chosen due to its experience of transformation from a traditional fabric to a modern urban context.

In this study, four blocks (2, 3, 7, and 9) that have experienced the most significant changes were selected for detailed analysis (Figure 1). These blocks were

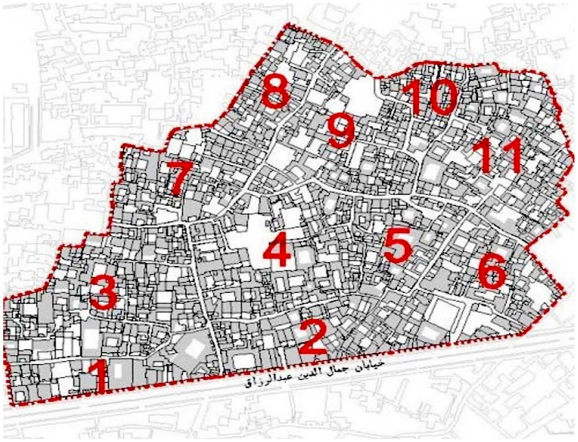

Figure 1. Numbering blocks in the Jamaleh neighborhood.

chosen because they represent areas where the transition from traditional to modern fabric is most evident, allowing for a focused exploration of the defined criteria and their application.

Initially, relevant theoretical principles related to morphology were presented through an analysis of existing studies. Subsequently, a descriptive-analytical method was employed, based on a morphological examination of the Jamaleh neighborhood and a comparative study of its urban fabric over two periods. Criteria were then defined for evaluating city plots to achieve a more sustainable urban pattern.

4. Establishing Evaluation Criteria for More Sustainable Urban Plot Patterns

Various direct and indirect studies have been conducted to establish criteria for evaluating the urban environment. Notably, several align closely with the objectives of this research. Bentley et al. (2013) identify key qualities for achieving a responsive environment, including permeability, variety, robustness, visual appropriateness, richness, personalization, and legibility. Similarly, Einifar (2006), referencing Grant, compares 20th-century neighborhood patterns and highlights shared core principles despite their varied names. Neighborhood patterns from the first half of the 20th century aimed to improve urban living conditions by improving connections with nature, promoting social equality, and ensuring community stability. In contrast, those proposed in the latter half of the century emphasized mixed-use spaces, diverse housing types, compact forms, walkable environments, multimodal transportation options, vibrant public realms, high-quality urban design, and efficient streets.

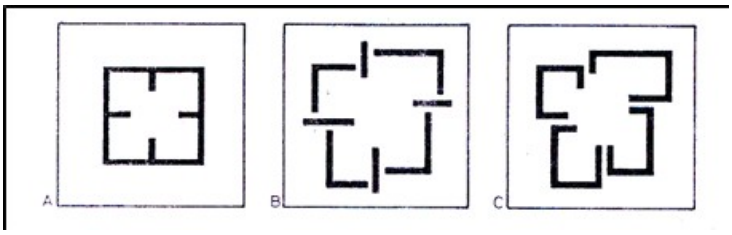

Figure 2. The expressive potential of an element as a unified whole depends on three factors: the number of plots, their types, and the interrelationships between them within a system (Grutter, 2009).

In traditional urbanism, the creation of a coordinated city context is driven by the significant relationship between individual plots and the whole. City plots are arranged next to each other as constituent elements of the urban fabric, not only influencing public spaces through their qualitative and quantitative aspects (as individual plots) but also contributing to a unified, coordinated totality when combined. As Grutter (2009) states, the expressive capacity of an element as a whole depends on three factors: the number of plots, the type of plots, and their interrelationships within a system (**Figure 2**). Tavasoli identifies several principles that

organize urban spaces in traditional Iranian urbanism, including integration, spatial enclosure, scale and proportion, simplicity, and the dynamic and static characteristics of enclosed spaces (Tavasoli, 1997: pp. 23-73). Similarly, Khorasgani et al. (2023) highlight the role of historical contexts in fostering a dynamic relationship between people, place, and time. Through a landscape approach, components such as a sense of belonging, personal and collective memories, social vitality, and sensory richness contribute to the continuity and vitality of urban spaces, ensuring their enduring relevance.

The Leadership in Energy and Environmental Design (LEED) guideline sets a standard for guiding and promoting the comprehensive design of buildings across five areas: existing buildings, new buildings, commercial buildings, residential buildings, and neighborhood development. LEED for Neighborhood Development (LEED-ND) combines green construction principles with smart growth strategies. It is based on the ten principles of the Smart Growth Network, which include density, proximity to transportation networks, mixed land uses, diverse housing patterns, and a walkable and bicycle-friendly design (American Planning Association, 2006). Regarding the form of cities and thermal comfort, Eskandar et al. (2022) indicate that the thermal status of the streets next to the old plots was better than the streets next to the mixed plots, while the mixed plots demonstrated better thermal conditions than plots with new patterns.

Today's buildings have different levels of energy consumption and carbon dioxide output based on factors such as urban morphology, building physics, construction technology, energy systems, and occupant's behavior. The *Centre Scientifique et Technique du Bâtiment*/the Scientific and Technical Building Centre (CSTB) has analyzed the environment-friendly criteria for the urban context of the city of Paris, and 96,000 residential buildings in Paris have been patterned by the *Atelier Parisien d'Urbanisme*/the Parisian Urbanism Agency (APUR) for calculating the heat energy (Salat, 2009: p. 598). The results of combining these two studies as the base and foundation of a comparative study between city form parameters and their environmental effects have been investigated through an article by Salat. In establishing a relationship between city form and ecological effects, he introduces the criteria of form factor and city form efficiency (**Figure 3**).

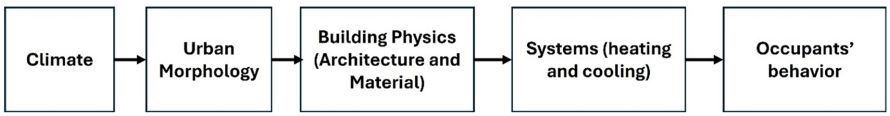

Figure 3. Effective factors on energy efficiency—Source: Ratti et al. (2005).

The shape factor is calculated by dividing the outer built surface area by size. The lower this ratio, the more compact and energy-efficient the context. The second index for assessing the city form efficiency is the ratio of the building's passive volume to its built volume. The larger this ratio, the spaces that have more of a need for ventilation and artificial lighting, would lessen. According to **Figure 4**,

this ratio is higher in compact contexts.

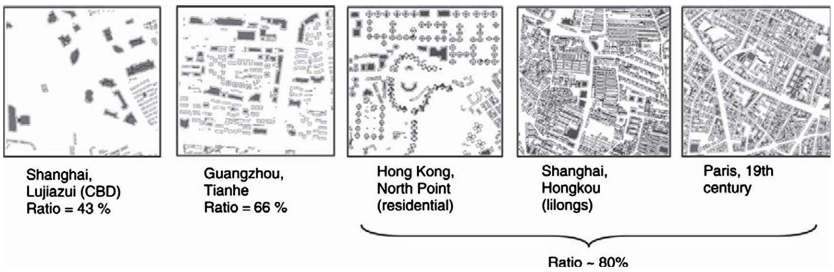

Figure 4. Building's passive volume to its built volume in Shanghai, Guangzhou, Hong Kong and Paris.

Hence, the presented information regarding the subject of morphology, relevant concepts with neighborhood formation in the second half of the 20th century, traditional urbanism properties, and practical form factors on urban context's energy-efficiency have been used in line with offering a more sustainable city plots pattern (Table 2). The criteria have been categorized into four general categories morphological, environmental, visual, and movement and accessibility.

Table 2. Relevant studies in evaluating urban environment and derived indices from them for evaluating plots and city block pattern 1.

Author	Research Related to Urban Environment Evaluation		Criteria for Evaluating Plots Based on Related Research
	Purpose	Indicators	
Bentley et al. (2013)	Achieve responsive environments	permeability, variety, robustness, visual appropriateness, richness, personalization, and legibility	Block depth, enclosure, variety and mixed uses, block orientation
Grant (2006) — First half of the 20th century	Achieving the neighborhood patterns in creating a coherent local community through the physical built environment	The connection with nature, social equality, and the sustainability of life in the local community	Safety
Grant (2006) — The second half of the 20th century		It is a combination of diverse housing types, urban form, pedestrian-friendly environments, transportation options, an attractive public realm, high-quality urban design, centrality of urban and commercial functions, clear boundaries, and narrow, efficient streets.	Diversity and mixed uses, density, enclosure
Tavasoli (1997)	Defining the principles of urban spaces in traditional urban planning	The principle of interlinking space enclosure, the principle of scale and proportion, contrasting space, simple principle, static and dynamic characteristics of enclosed spaces	Street's enclosure, privacy, inward orientation
Environmental and Energy Design Guide (LEED) (American Planning Association, 2006)	Buildings comprehensive design guide	Density, proximity to the transportation network, a mix of uses, a mix of housing patterns, and pedestrian and bike design	Density, diversity, and mix used buildings
Salat (2009)	Describing the effective factors on energy efficiency	Urban morphology, architectural archetypes, construction technologies, energy systems, and inhabitant behavior	Adaptability to climate, plots proportions and orientation

For evaluating the morphological aspect, the following criteria, "Enclosure and Geometry of Private Open Spaces", "Public Open Space Enclosure", "Privacy and Inward Orientation", "Safety", "Diversity and Mixed uses", and "Compactness"; for evaluating the environmental aspect, the following criteria, "Orientation of plots", "Plots' Proportion" and "Adaptability with Climate"; for assessing the visual element, the "Streets' Enclosure" and "Way finding"; and for evaluating the movement and accessibility aspect "Block Depth" were defined (Table 3).

Table 3. Evaluation criteria for city plots and blocks.

Dimensions	Criteria	Evaluation Approach	Scoring
1-Morphological Dimension	1. Enclosure and Geometry of Private Open Spaces	Plots' shape and their impact on the private open space	Classifying plots into the following types of 60% built, one-side built, L-shape, two-side parallel built; and assigning scores of 1 to 5 to these types; respectively
	2. Public Open Space Enclosure	Plots' shape and their impact on streets' enclosure	Assigning scores of 1 to 5 to types in the following order: 60% built, one-side built and no-built; L-shape, two-side parallel built; U-shape; central yard and 100% built
	3. Privacy & Inward Orientation	Plots' shape and their impact on privacy and orientation	Assigning scores of 1 to 5 to types in the following order: 60% built, one-side built, no built, 100% built; L-shape; two-side parallel built; U-shape, courtyard
	4. Safety	Number of active frontages beside empty plots	Assigning the highest score to the plot without a build that has active facades and active surveillance, and the lowest score to the plot with a build that has three sides without active surveillance and activity
1-Morphological Dimension	5. Diversity and Mixed Uses	Number of active frontages in every 100 meters	Assigning the highest score to streets in which the number of active frontages is more than 15 in every 100 meters; and the lowest score to 1 to 2 active usages in every 100 meters
		The percent of active frontages length in every street	Assigning the highest score to streets in which the length of business row, cultural, religious, educational, and… usages in the local street is more than 30% and the lowest score to the length of less than 10%
	6. Density	The percent of built and empty spaces in the block	Assigning the highest score to blocks where the building footprint covers more than 70% of the area, and the lowest score to blocks where the building footprint covers less than 60%
	7. Plots Orientation	Plots' shape and orientation and their impact on the access to natural light	Assigning the highest score to plots with a courtyard and U-shape type and Northwest-Southeast orientation and the lowest score to plots with 60% built patterns and with Northeast-Southwest direction
2-Environmental Dimension	8. Plots' Proportion	The ratio of the east-west length to the north-south length of the plot	Assigning the highest score to plots with courtyard and U-shape type and East-West elongation towards North-South (1 to 1.3) and the lowest score to plots with a 60% built pattern and North-South elongation towards East-West (1 to 5)
	9. Adaptability to Climate	Plots' shape and their impact on adaptability with climate (measured by Ecotect)	Assigning the highest score to plots with courtyard type and the lowest score to one-side built types based on calculating the necessary energy level for creating comfort conditions during winter and summer, measured in watt-hours per square meter using Ecotect software

Continued

3-Visual Dimension	10. Streets' Enclosure	Streets' height-to-width ratio	Assigning the highest score to streets with a width-to-height ratio of 3 to 1 and the lowest score to those with width to height ratio of 6 to 1
	11. Way Finding	Direction change throughout movement in streets	Assigning the highest score to the rotation level of 0 to 180 degrees in a street for reaching the destination, and the lowest score to those with a rotation level of exceeding 720 degrees
4-Movement & Accessibility Dimension	12. Block Depth	Counting the number of streets from the main street until reaching the desired street	Assigning the highest score to a street depth level of 3, 4, 5 for reaching the destination and the lowest score to a street depth level of 9, 10, 11

Source: Authors.

Further, the 12 criteria are discussed, and how they are quantified to evaluate the Jamaleh neighborhood context is explained. Several proposed methods or techniques used by other researchers in this field were used to quantify the requirements in every case they are mentioned. The criteria selection method based on previous literature is discussed according to the four category in Table 3. As mentioned earlier, the defined criteria can become more complete and be used as a basis for future studies. The more complete these criteria are, and the more precise their evaluation method is, achieving the goal, meaning defining a more sustainable pattern for plots, will be more apparent.

1) Enclosure and Geometry of Private Open Spaces

Tavasoli (1997) states that enclosing spaces is the first principle in designing urban places. Without proper enclosure, an attractive city space cannot be achieved. This principle is evident in the old cities of many regions worldwide, with differences primarily in how spaces are enclosed, such as aspect ratio, shape, access, and enclosing boundaries. In studying the historical changes in the Jamaleh neighborhood, we observe a decline in the number of courtyard and U-shaped plots and an increase in shapeless private and public spaces. Consequently, for evaluating the enclosure and geometry of private open spaces in the Jamaleh neighborhood, the lowest score was assigned to 60% of built and one-sided built types, while the highest score was given to the courtyard type.

2) Public Open Space Enclosure

In scoring based on the enclosure of public open space, the courtyard and 100% built types, with defined walls on all four sides of the area, are most successful in creating an enclosed public space. Next, the U-shaped type, with three defining walls, followed by the L-shaped and two-sided built types with two walls. The 60% built and one-sided built types, with one wall, come next, and finally, plots without any built structures or walls have the least potential for creating an enclosed public space.

3) Privacy and Inward Orientation

One of the key effects of modern urbanism on traditional Iranian architecture

has been the shift toward outward-oriented building forms. Traditional inward-oriented designs, such as central courtyard houses, were well-suited to the local culture. In contrast, the adoption of modern structures, without consideration of cultural and local characteristics, has led to issues that are clearly visible in the cityscape. The scoring of plots with different types, based on their privacy and inward orientation, is presented in Table 3.

4) Safety

Given the influence of unbuilt plots, which constitute a significant portion of the Jamaleh neighborhood, these spaces could become targets for criminal activity if left abandoned. For each plot, the score was recorded based on the presence of inactive land without surveillance (i.e., the absence of windows overlooking the street or adjacent areas with no traffic or eyes on the street). The mean score of the block was then calculated based on the safety criteria for these unbuilt plots.

5) Diversity and Mixed Uses

Diversity in activities, forms, and people contributes to a rich understanding of a place. Different users, with their varied perspectives, interpret and understand spaces in distinct ways, offering a range of meanings (Bentley et al., 2013: p. 59). In this research, commercial, cultural, educational activities in the streets of the Jamaleh neighborhood—activities that create diversity in form and use, attract people at different times, and ensure the neighborhood's vibrancy—are defined as an index for evaluating the streets based on the diversity and mixture of uses criterion. Llewelyn Davis proposes a scale for assessing designs based on active frontage (Table 4). His method was applied to measure the diversity criterion, using two approaches: (1) the percentage of street length occupied by these active frontages, and (2) the number of these active frontages within every 100 meters (Carmona et al., 2008).

Table 4. The manner of streets' scoring based on the diversity and mixture uses, number of active frontages in every 100 meters; derived from Loulin Davis cited by (Carmona et al., 2008).

Score	Distribution of active users per 100 meters
5	More than 15 premises per 100 meters
4	10 to 15 premises per 100 meters
3	6 to 10 premises per 100 meters
2	3 to 5 premises per 100 meters
1	1 to 2 premises per 100 meters

6) Density

In the density criterion, the block's footprint was used as an index to measure the context's compactness. Golkar (2000) argues that in cities with hot and arid climates, the morphology of the city's structure, along with the distribution and combination of different land uses, can serve as the foundation for reducing energy consumption by shortening travel distances.

7) Plots' Orientation

In this research, the plots' orientation of the Jamaleh neighborhood context has been evaluated regarding their orientation and their impact on the access to natural light.

8) Plots' Proportion

In determining the optimal proportions for urban plots, the ideal building form is one that minimizes heat loss during winter and gain the least heat from sunlight and the surrounding environment in summer. The most efficient building form is a square, as it has the smallest exterior surface area relative to its volume (Kasmaei, 2003). Consequently, the orientation of a building, whether elongated along the North-South or East-West axis, can significantly influence the amount of heat it gains in summer and loses in winter.

9) Climate Adaptability

The courtyard pattern is significantly influenced by the arid climate; however, due to its other advantages, it has been adopted in various climate zones. This pattern has appeared in cities spanning from the Persian Gulf to the Yazd desert, as well as in more temperate regions like the Zayandehroud River, cities such as Tehran, and colder cities like Tabriz. To study how the courtyard, U-shape, L-shape, and two-side parallel built types respond to heat gain in the summer and heat loss in the winter, these four types were modeled using Ecotect software. The software calculated the necessary heat for creating comfortable winter conditions (Heating) and the cooling required for summer comfort (Cooling) over the course of a year, measured in watt-hours. The scores for each of the four blocks were then determined based on these types.

10) Streets' Enclosure

The relationship between length, width, and height is crucial for determining the spatial enclosure, with the width-to-height ratio of the walls being particularly significant. This relationship was examined in relation to the streets' enclosure criterion. According to a study by Ghaffari (1992), the perception of street enclosure varies based on the width-to-height ratio. In a 1:1 ratio, the street is perceived as narrow; in a 2:1 ratio, the street feels enclosed but not narrow; in a 3:1 ratio, the proportions are optimal; and in a 6:1 ratio, the sense of enclosure is weak. Therefore, when scoring streets based on the enclosure criterion, the highest score was given to the 3:1 width-to-height ratio, while the lowest score was assigned to the 6:1 ratio.

11) Wayfinding

Understanding the of navigation is shaped by elements such as the sky, the gravity force, and the sun's movement carrying special significance in many cultures. The physical layout of urban spaces and their relationship with geographical directions significantly influence navigation and an individual's perception of the environment (Ghaffari, 1992: p. 35). In the case of the Jamaleh neighborhood, its organic urban fabric, with streets leading to dead ends, can lead to navigational difficulties, especially for those unfamiliar with the area. To quantify this aspect in the streets' navigation criterion, the degree of rotation along the route from

start to finish has been considered.

12) Block Depth

One of the methods used to study the relationship between the city context and events, through analyzing the street network, is the Space Syntax method. The concept of depth in this method describes the distance between spaces. In this study, block depth refers to the number of spaces one must pass through to reach a particular space. In scoring based on the residential context type (and the need for safety and comfort for residents), the Jamaleh neighborhood was assigned the highest scores of 3, 4, and 5 for the depth of its streets.

Considering the mentioned explanations, for quantifying the qualities, city plots in four blocks (2, 3, 7, and 9 blocks) were scored based on 1 to 5 scores. Four blocks of the Jamaleh neighborhood were selected to apply its features to the whole neighborhood. The mean score of plots in blocks 2, 3, 7, and 9 were calculated based on the defined criterion briefly described in Table 3.

5. Research Findings

After the calculations were conducted in the evaluation step, the blocks' comparative graph based on the criteria in Table 3 was drawn. The score for blocks 2, 3, 7, and 9 in each criterion has been presented comparatively (comparing the score for each block in different criteria with itself and the other three blocks) in two charts (Figure 5 and Figure 6). The final score has been compared in the last chart (Figure 7) to compare the blocks' scores in two periods. This chart shows that the block's score has declined in many defined criteria.

Among the scores of different criteria in 1976, blocks 2 and 7 received the highest scores based on six out of the 12 criteria. Blocks 3 and 9 received the first score in the two criteria and, respectively, in the evaluation based on eight and seven criteria, received the second score. This is while the total scores show that blocks 7, 3, 9, and 2 received the highest scores, respectively, and based on the defined criteria for achieving more sustainable plots, they act better, respectively.

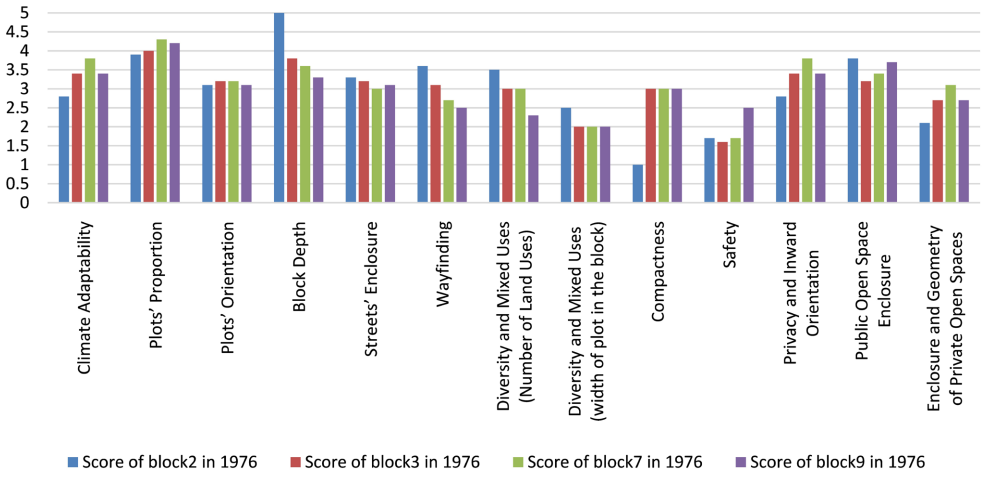

Figure 5. Comparative Graph of the scores of blocks 7, 3, 2, and 9 in the year 1976 based on the 12 criteria.

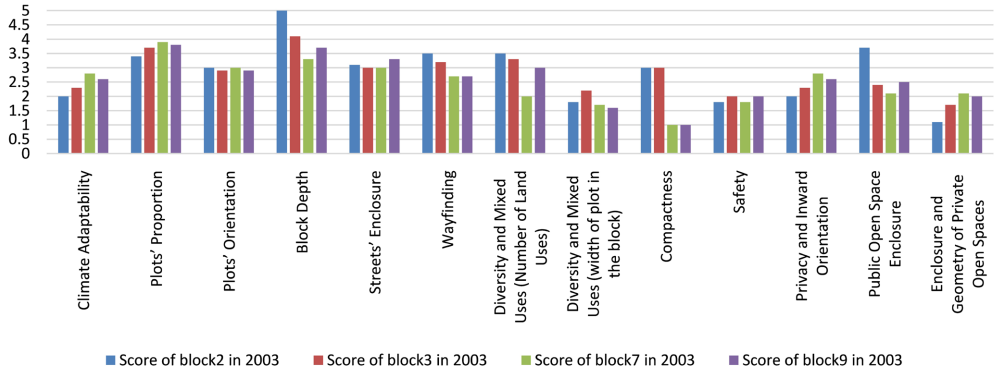

Figure 6. Comparative Graph of the scores of blocks 7, 3, 2, and 9 in the year 2003 based on the 12 criteria.

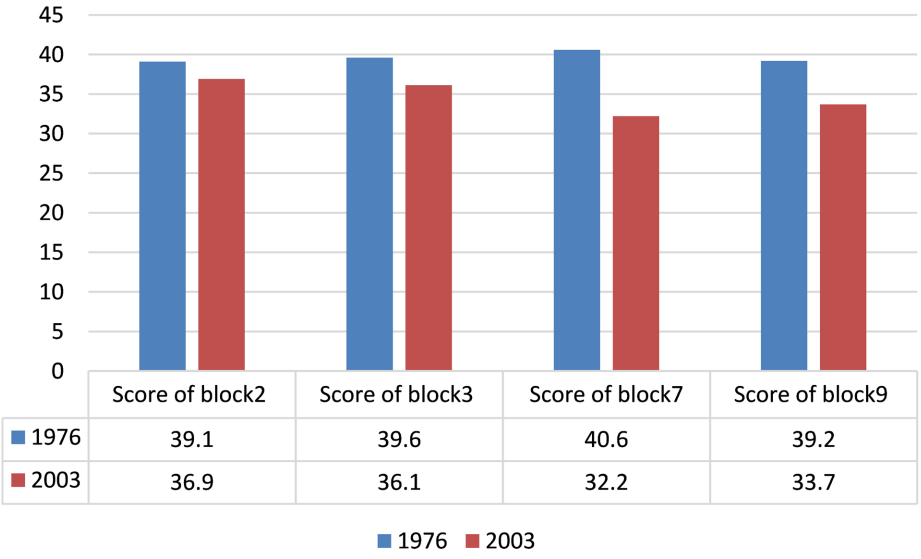

Figure 7. Comparison of Final Scores for Blocks 2, 3, 7, and 9 in 1976 and 2003.

In 2003, scores changed in the following manner: block 2 in the evaluation based on six criteria out of the 12 criteria, block 7 on five criteria, and blocks 3 and 9 received the first score in three and two criteria, respectively. The total scores show that blocks 2, 3, 9, and 7 received the highest scores, respectively.

6. Discussion

This research defined 12 criteria across four general categories—morphological, environmental, visual, and movement and accessibility—to evaluate urban plots and blocks for developing a more sustainable urban pattern. The Jamaleh neighborhood, situated in the historic core of Isfahan City, served as the case study, given its significant transition from a traditional fabric characterized by central courtyards to modern plots dominated by 60% built patterns.

The findings reveal a substantial degradation of sustainability indicators over time. For instance, Block 7, which scored highest in 1976, experienced the most pronounced decline by 2003, scoring lowest among the blocks analyzed. Similarly,

Blocks 3 and 9 lost their qualities in criteria such as inward orientation and privacy. While some aspects, such as movement and accessibility, improved, the overall points toward a decline in key sustainability indicators.

When comparing these findings to the theoretical principles outlined in **Table 2**, several correlations and divergences emerge:

Morphological Dimension

The loss of privacy aligns with Tavasoli's (1997) emphasis on inward orientation as a defining principle of traditional urbanism. The transformation of plots from central courtyards to linear, 60% built configurations has compromised this quality, supporting the notion that modern urban forms often neglect the cultural values embedded in traditional designs.

Environmental Dimension

The diminished adaptability to climate, reflected in lower energy efficiency scores (calculated via Ecotect), confirms Salat's (2009) argument that modern urban forms often fail to optimize energy systems and inhabitant comfort through traditional morphological archetypes.

Visual Dimension

The observed degradation in streets' enclosure ratios is consistent with Ghaffari's (1992) findings, which suggest that the perception of street enclosure is directly influenced by the width-to-height ratio of the street. These principles underscore the importance of spatial proportions in shaping sustainable and comfortable urban environments.

Movement and Accessibility

The improved accessibility aligns with 20th-century planning principles, which emphasize connectivity and efficient transportation options (Grant, 2006). However, this gain appears to have come at the cost of other critical dimensions like visual richness and morphological robustness.

The above comparisons highlight that while theoretical principles remain relevant, their application in modern urban transformation often leads to trade-offs between dimensions. For instance, improvements in accessibility have been achieved at the expense of environmental adaptability and morphological coherence.

Finally, this research underscores the adaptability of the proposed criteria to different cultural and geographical contexts. As noted, criteria such as privacy, and inward orientation are particularly relevant in cultures, such as Iran. Future studies could expand on these findings by incorporating additional cultural dimensions or refining evaluation methods to better balance competing priorities in sustainable urban planning.

7. Conclusion

In line with defining a more sustainable city plot pattern, plots across four blocks of the Jamaleh neighborhood in Isfahan City were compared over two time periods. The evaluation was based on form and morphological aspects, environmental

considerations, movement and access, and visual elements. Several criteria were proposed for the assessment and measurement of these plots based on their morphological features. The findings reveal that the transformation of the neighborhood's context reflects a shift from traditional courtyard and U-shape plot patterns to more modern forms such as one-side built, L-shape, and 60% built plots, indicating a significant change in the area's spatial characteristics.

As a result, the increasing popularity of modern form patterns has led to reduced enclosure in both private and public spaces, diminishing the concept of privacy and inward orientation. The traditional context of the Jamaleh neighborhood in Isfahan City, with its courtyard and U-shape plot types, is better suited to Isfahan's climate due to its orientation and optimal spatial arrangement. The small dimensions of the blocks and reduced rotation levels in the streets have also contributed to a decrease in the complexity of navigating the area. Ultimately, the criteria defined in this research for evaluating a more sustainable plot pattern can serve as a general guideline for similar studies, offering opportunities for further exploration in various aspects.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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