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# Spatial justice and infill development: towards a more balanced urban growth model for Mashhad in informal settlements

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## Abstract

The spatial-physical growth pattern of Mashhad in recent decades has been based on dispersed, horizontal expansion on the peripheries, neglecting inner-city potentials. This pattern has exacerbated spatial inequalities and residents' deprivation in informal settlements. This article critically re-examines this growth pattern and elucidates the role of infill development as a strategy for realizing spatial justice in these areas.

The present research is descriptive-analytical in nature and has been conducted using a library-documentary method and secondary data analysis. The research methodology was mixed, encompassing both quantitative and qualitative analysis. In the quantitative section, indicators of spatial justice were weighted using the analytic network process (ANP) model, and then the neighborhood composite index was calculated using the arithmetic integration method. Qualitative data were collected through semi-structured interviews with 15 urban experts and 12 local leaders.

The findings indicate that Mashhad's urban growth pattern, with its one-sided emphasis on "outward expansion," has reinforced three major structural deficiencies: (1) a deep spatial divide between affluent and deprived neighborhoods (spatial justice index range: 3.42 units), (2) ignoring inner-city capacities, such as vacant and underutilized lands, and (3) weakening social capital and limiting participation in informal contexts (high correlation of spatial justice with willingness to participate: 0.76–0.82).

The article concludes that integrating the two concepts of spatial justice and infill development can form the core of a major shift in Mashhad's urban planning, which, instead of unregulated outward expansion, focuses on revitalizing and rebalancing within the city and reducing the gap between formal and informal areas.

## Keywords

Balanced growth
Infill development
Informal settlements
Mashhad
Spatial justice

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## 1. Introduction

The accelerating trend of urbanization, which is projected to bring the world's urban population share to approximately 85% by 2100 (Oraiopoulos et al., 2025; UN-Habitat, 2022), is most intensely experienced in developing countries, where 90% of global urban population growth occurs (Shand & Ndezi, 2025). This acceleration has placed a dual burden on land, infrastructure, and services, and, combined with poverty and spatial inequality, has complicated the structural issues of cities (Alene, 2022; Triandafyllidou et al., 2024). Within this context, problems such as pollution, widening inequality, and the proliferation of informal settlements have intensified (Rybski & González, 2022). The physical expansion of cities in recent decades has been mainly shaped by horizontal development and the acquisition of peripheral areas, a process known in the planning literature as "urban sprawl" (Elkawy & Ahmed, 2023; Shojaeian et al., 2023). This pattern indicates that cities are growing faster than their population (Khosh Sima et al., 2020), with physical development exceeding real needs (Arvin & Zanganeh, 2020). In the Global South, the inefficiency of land and housing policies, large-scale migration, and the struggle of low-income households to find affordable housing have exacerbated this pattern (Ghodsi et al., 2021). The consequences include increased infrastructure costs, the destruction of agricultural land, reduced open spaces, and intensified social segregation (Elkawy & Ahmed, 2023; Parizadi et al., 2022).

One of the most significant outcomes of this process is the expansion of informal settlements (Hossain, 2021), a phenomenon described as "the face of 21st-century urbanization" (Bettencourt & Marchio, 2025). These settlements are a direct reflection of spatial inequality and the failure of formal planning and housing systems (Azhar & Buttrey, 2021; Boanada-Fuchs et al., 2024), and are projected to house over three billion people by 2050 (World Bank, 2022; UN-Habitat, 2020). The lack of tenure security, weak infrastructure, and poor-quality services creates a cycle of reproducing social and spatial inequality (Taherian, 2024; Agyabeng et al., 2022).

In response to the consequences of horizontal expansion, approaches such as smart growth, livable communities, and infill development[i] have emerged (Mahabadipoor et al., 2025). Infill development, as an alternative to uncontrolled urban expansion, emphasizes utilizing underutilized or vacant lands within existing urban boundaries and relying on current infrastructure (Ghodsi et al., 2021). As part of a smart growth strategy, this approach has gradually become a strategic alternative to horizontal development and urban sprawl (Jun et al., 2024). Many cities have the potential to create new uses within these already developed areas without placing an additional burden on unused lands and resources (AlHasawi et al., 2024). This approach aims to achieve a more compact, sustainable, and equitable city, simultaneously considering social, economic, and environmental outcomes (Parizadi et al., 2022). From this perspective, infill development can be a tool for reducing spatial inequality, as it enables improved access, enhanced spatial cohesion, and increased capacity in underprivileged neighborhoods (Mohammadi-Hamidi et al., 2022).

In Iran, similar to many countries in the Global South, rapid urbanization has transformed the spatial structure of cities. An urbanization rate of approximately 77% has made informal settlements a persistent part of the reality of metropolitan areas (Statistical Center of Iran, 2025). Mashhad is a prime example; it houses about 30% of its population in only 10% of its area, with the extent of its informal settlements exceeding 3,894 hectares (Aghajani et al., 2024; Baghban & Minaei, 2023). Marginalization in Mashhad is not a phenomenon detached from the city, and its social, economic, and environmental consequences affect the entire urban structure. Alongside these challenges, the presence of vacant and underdeveloped lands within the city provides a significant capacity to direct development from within. In such a context, measuring spatial justice in informal settlements with components such as spatial cohesion, access, environmental vibrancy, capacity, and compatibility is the starting point for analyzing spatial inequality. By examining three neighborhoods with varying levels of spatial justice, this research seeks to analyze the relationship between spatial justice and the feasibility of infill development in a real-world setting. The research hypotheses are based on several ideas: First, spatial justice in Mashhad's informal settlements is uneven, and differences in indicators such as access and spatial cohesion are more pronounced. Second, access and spatial cohesion indicators contribute more significantly to explaining the pattern of inequality. Third, the logic of realizing infill development differs between deprived and privileged neighborhoods. In deprived neighborhoods, infrastructural and social constraints are the main obstacles, whereas in privileged neighborhoods, land

management and land-use regulation play a more significant role. Based on this, the main hypothesis of the research is that there is a significant relationship between spatial justice and the feasibility of infill development—a relationship that links decreased spatial justice to reduced potential for implementing the infill development. Elucidating this relationship can provide a basis for rethinking Mashhad's urban growth model and offer strategies to enable a transition from horizontal expansion towards an endogenous, efficient, and justice-oriented model.

To test the research hypotheses and analyze a multi-dimensional issue (spatial, social, and economic) in Mashhad's informal fabric, this study employs a mixed-methods research approach. This choice is necessary because complex urban phenomena, such as spatial justice and the feasibility of infill development, are inherently multi-dimensional, and relying solely on a quantitative or qualitative method cannot fully explore the different layers of the issue. Quantitative data (such as physical-spatial indicators) provide a macro and comparable picture of inequality, but to understand the "why" behind these inequalities and to identify the contextual barriers and opportunities for infill development, collecting and analyzing qualitative data from stakeholders and local experts is essential. In the quantitative phase, the analytic network process (ANP) model was used to weight spatial justice indicators. Unlike simpler weighting methods (such as AHP or Delphi), the ANP model was deemed more suitable for this research due to its ability to model interdependencies and feedback between criteria and sub-criteria (e.g., the effect of access on spatial cohesion and vice versa). This feature is an advantage in evaluating complex urban systems, where various factors operate in an intertwined manner. Therefore, the present methodological combination (quantitative-qualitative integration using ANP) is not an arbitrary choice but a methodical response to the intertwined and multi-layered nature of the research problem in the specific context of Mashhad. Elucidating this relationship can provide a basis for rethinking Mashhad's urban growth model and offer strategies to enable a transition from horizontal expansion towards an endogenous, efficient, and justice-oriented model.

## 2. Theoretical and experimental background

### 2.1. Theoretical foundations

The phenomenon of informal settlements in the Global South has its roots in the developments of the 1960s and 1970s, a period when researchers such as Abrams, Hart, and Turner considered these spaces the product of the formal system's inability to meet the housing needs of low-income groups (Atkinson, 2024; Fouad & Abbas, 2021). Although the term "informal settlement" is now established in planning literature, its origins trace back to the concept of the "slum" in 19th-century Britain (UN-Habitat, 2025; Mayne, 2017) and are known in various countries by terms such as favela, población, and shantytown (World Bank, 2022; Bakhaty et al., 2023), and in Iran by the term "marginalization" (Bagheri Miab & Karimikia, 2022; Nowin et al., 2022; Allahgholitabar et al., 2025; Teymouri, 2024). Most definitions highlight three characteristics for these settlements: non-compliance with formal land and construction laws, lack of basic services, and tenure insecurity (UN-Habitat, 2017; Marutlulle, 2017). These spaces are typically formed on land lacking formal title deeds and in hazardous locations (Hailu et al., 2024; Ampofo et al., 2024). They are characterized by high density, non-durable building materials, and low-quality urban services (Moretti et al., 2024; Ziorklui et al., 2024). Key drivers of their emergence include poverty, migration, weak land governance, and structural inequalities (Bakhaty et al., 2023; Baye et al., 2020). In Iran, rural-urban migration has been the most important driver of this growth (Chen et al., 2017; Vearey et al., 2017).

From a theoretical perspective, four main approaches explain these settlements: land governance, colonial legacy, inefficient economy, and mismatch between housing supply and demand (Marutlulle, 2017; Baye et al., 2020). The evolution of discourse in recent decades shows that initial approaches based on elimination and demolition (Atkinson, 2024; Smit, 2021) have given way to new perspectives that view informal settlements as part of the urbanization process and manifestations of residents' creativity, self-organization, and resilience (UN-Habitat, 2025; Dovey et al., 2020). In this view, the informal economy, social innovation, and self-organizing methods form a significant part of the internal dynamism of these spaces (Agyabeng et al., 2022; Galdini & De Nardis, 2023; Miranda et al., 2025).

Extending this discussion, the concept of spatial justice provides a normative framework for analyzing these settlements. Spatial justice denotes the fair distribution of resources, services, and opportunities in space (Feitosa et al., 2024) and, in its theoretical evolution from classical justice traditions to radical geography, has become a concept linked to power structures and

the processes of space production (Dadashpoor & Dehghan, 2025). Spatial justice is usually examined at two levels: distributive and procedural. The first emphasizes equality in access to services, while the second focuses on decision-making processes and democratic participation (He, 2020; Dadashpoor et al., 2015). Thinkers such as Harvey and Soja have considered informal settlements a clear example of spatial injustice (Soja, 2010; Harvey, 2008). In recent literature, a four-dimensional framework of distribution, recognition, procedure, and capability has also been proposed for a more comprehensive analysis of this concept (Xin & Guo, 2025; Ahmed et al., 2019). Although there is no consensus on a single definition of spatial justice (Moroni & De Franco, 2024), today this concept is not only a theoretical domain but also a practical framework for addressing territorial inequalities (Jones & Moisio, 2025).

In response to the consequences of horizontal urban expansion, approaches such as the compact city and smart growth have emerged as sustainable models (Bibri et al., 2020; Bin Sulaiman, 2023). Infill development is one of the key tools of these models and relies on utilizing vacant or underused lands within existing urban boundaries (Ghodsi et al., 2021). This approach contributes to urban sustainability and efficiency by reusing existing infrastructure, promoting mixed-use, increasing density in a targeted manner, and revitalizing inefficient fabrics (Ahvenniemi et al., 2018; AlHasawi et al., 2024). In Iran, this approach has also been proposed as an effective policy for improving and regenerating inefficient urban fabrics (Parizadi et al., 2022).

These three concepts are linked at the point where informal settlements are considered a tangible manifestation of spatial inequality (Soja, 2010; Marnane & Greenop, 2023). In such a context, infill development is not merely a physical intervention; rather, it is a strategy for redistributing services, reducing spatial inequality, strengthening the local economy, and recognizing the residents' identity and needs. Policies of demolition and forced eviction are examples of procedural injustice that have deepened marginalization (Ouma et al., 2024). In contrast, the new perspective on informal settlements as "living laboratories" of space production (Dovey, 2019; Kamalipour, 2023) aligns with the principles of spatial justice, including fair distribution, inclusive participation, and recognition of residents' identity (Fainstein, 2010). From this perspective, infill development in informal settlements can be a mechanism for reducing distributive injustices and strengthening local participation, while, by creating mixed uses and curbing horizontal expansion, it can contribute to urban resilience and sustainability (Zhang et al., 2023; Bibri et al., 2020).

In summary, these three concepts gain meaning through an internal connection: informal settlements reflect structural inequality; spatial justice allows analysis and critique of this situation; and infill development indicates a path for correction and regeneration that relies on internal capacities, participatory approaches, and gradual transformation. This framework provides a theoretical link that underpins empirical analysis and policy design in the present research.

## 2.2. Literature review

The theoretical literature of this research can be seen as a strand that begins with spatial justice, continues through infill development, finds meaning in urban growth patterns, and ultimately reaches its focal point in informal settlements.

At the global level, the concept of spatial justice has evolved from a simple distributive view to a process-oriented, power-centric framework. Studies such as Dadashpoor & Dehghan (2025) and Capra-Ribeiro (2024) show that justice is not merely the product of service distribution but the outcome of decision-making methods and mechanisms of access to power. The study by Setianto & Gamal (2021) and Moroni & De Franco (2024) complements this view by focusing on the structural roots of injustice. At the intersection of theory and practice, research such as Schwab (2018) and Rigon (2022) examines experiences of infill development, while the warning by Xin & Guo (2025) about the risk of social exclusion in seemingly justice-oriented projects emphasizes the importance of local participation and attention to vulnerable groups. The addition of dimensions such as transportation (Tzanni et al., 2022) and micro-recreational spaces (Ye & Yang, 2023) also ties spatial justice to the quality of everyday life.

In Iran, this theoretical background has materialized in the "center-periphery" model—a pattern repeated in cities such as Tehran, Ahvaz, and especially Mashhad. Research by Rezaee et al. (2025) has identified structural deprivation of northern and eastern areas of Mashhad, and studies by Pourahmad et al. (2021) and Saberi et al. (2024) have attributed it to urban rent, weak planning, and the dominance of influential

groups. Works related to informal settlements, including Saeedi Mofrad et al. (2020, 2021) and Afsari et al. (2021), show that these neighborhoods suffer from compound deprivation, a combination of service shortages and the erosion of social capital.

In the domain of infill development, global and Iranian literature highlight the movement of this concept from a purely physical strategy to a governance-oriented framework. Studies by Jun et al. (2024) using deep learning methods, AlHasawi et al. (2024) with a financial-governance approach, and Ghodsi et al. (2021) by proposing the criterion of "excess infrastructure capacity" show that infill development must be viewed on a scale beyond land and within the framework of infrastructure and governance. In Iran, research by Arvin & Zanganeh (2020) has identified the roots of obstacles in the administrative and economic system, while studies by Khosh Sima et al. (2020) and Shojaeian et al. (2023) have documented cities' internal capacities. The outcome of these two currents shows that the dispersed and peripheral growth, also confirmed in studies by Mahabadipoor et al. (2025) and Ghazanfarpour et al. (2022), stems not from a lack of inner-city land but from weaknesses in the governance system. Other research, such as Karami Shaban Abadi & Qanbari (2021) and Moghadam & Maleki (2025), has also sought to strengthen infill development within the theoretical framework of smart growth and from the perspective of executive solutions.

Urban growth literature forms the intermediary link in this chain. Global studies such as Hassan et al. (2023), Rizkiya et al. (2023), He et al. (2019), Li et al. (2021), and Behnisch et al. (2022) provide a comparative perspective on growth trends. Domestic research, such as Nasehi et al. (2023), Yousefi Azarabarghani et al. (2022), and Zebardast & Ghanooni (2021), demonstrates the inefficiency of the dispersed growth pattern.

Finally, the literature on informal settlements forms the focal point of this chain. Global literature, with works such as Atkinson (2024), Agyabeng et al. (2022), Bettencourt & Marchio (2025), Boanada-Fuchs et al. (2024), Dovey et al. (2020), Iranmanesh & Kamalipour (2025), and Samper et al. (2020), provides a layered picture of governance, vulnerability, morphology, typology, property rights, and planning innovations. These studies express a spectrum of approaches, from in-situ upgrading (Pakzad et al., 2023) to asset-based and social capital approaches (Hashempour et al., 2022; Kheiroddin & Salahimoghadam, 2021; Beidi Gharaghyeh & Arbabi, 2022), and from institutional root-cause analysis (Hakimi et al., 2025; Jamini et al., 2022; Eskandari Dorbati et al., 2022; Rezaei et al., 2023) to methodological diversity (Arzhangi et al., 2021; Sharif Zadegan & Safavi, 2023).

The synthesis of this literature clarifies three points: Unjust growth patterns, spatial injustice, and the expansion of informal settlements are three links in a single process; infill development is only effective when viewed as an institutional and social strategy; and the existing research gap is the absence of a framework that causally and integrally examines these three domains. The present research is precisely in response to this gap. It aims to provide an integrated framework in which urban growth pattern is the cause, spatial injustice the effect, and infill development the corrective strategy.

### 2.3. Conceptual research model

The conceptual model of this research is a dynamic and learning cycle that begins with understanding the reality of Mashhad's informal settlements and continues with continuous rethinking of the urban growth model. At the center of this cycle lies the connection between two theoretical components: spatial justice as the framework for analyzing and critiquing the existing situation, and infill development as the corrective path to upgrading these spaces. This connection allows the move from "problem identification" to "intervention design" to rely not only on experience but also on measurable analyses.

The first step is to describe the current state of Mashhad's informal settlements, an analysis encompassing spatial, social, and infrastructural dimensions, providing the necessary groundwork for evaluating spatial justice and internal development capacities. From this stage, the model proceeds along two simultaneous paths: in one path, spatial justice indicators clarify the level of privilege and inequality; in the other, the capacity for infill development is measured within the same neighborhoods. One creates a picture of inequalities, and the other a picture of potential opportunities. The next stage is the convergence point of these two analytical streams, where data related to spatial justice and infill development are integrated. Analyzing the overlap of these two datasets reveals neighborhoods that have both the greatest spatial injustice and the highest internal development capacity. These neighborhoods naturally become priority areas for intervention.

Subsequently, the model enters the decision-making stage; the identified areas are prioritized based on the intensity of inequality, development capacity, and socio-economic returns. The outcome of this step is executive recommendations for urban management that target resource allocation. From these analyses emerges the stage of rethinking the urban growth model. The output of this stage provides an alternative to horizontal and dispersed growth and directs the city's development path towards strengthening internal capacities, reducing spatial inequality, and alleviating pressure on the periphery. The strategies at this stage are both feasible and compatible with justice-oriented goals.

The cycle is completed with monitoring and feedback. The results of implementing the strategies are fed back to the beginning of the cycle, turning the model into a learning system—a system that can remain flexible against future urban changes. Overall, this conceptual model creates a coordinated chain of cognition, analysis, decision-making, and intervention—a chain whose goal is upgrading informal settlements through an internal, participatory, and justice-oriented approach.

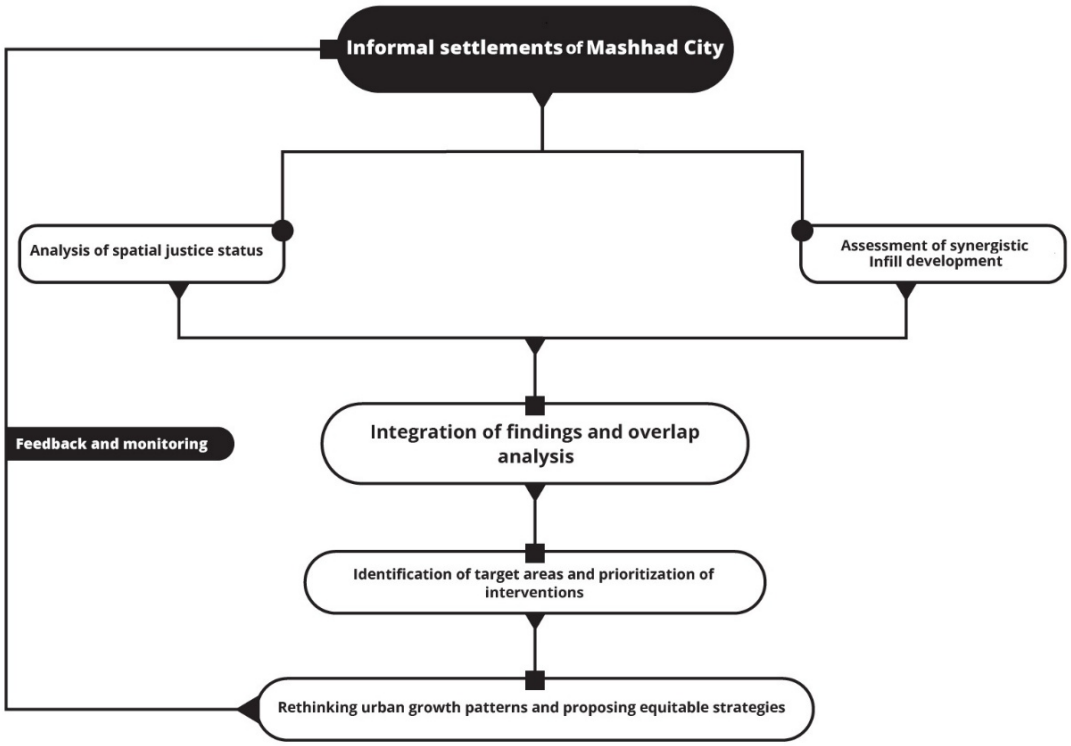


**Figure 1. Conceptual research model**

## 3. Methodology

### 3.1. Introduction to the study area

The metropolis of Mashhad, the second-largest city in Iran, is located in the northeast of the country on the southern slopes of the Binalood mountain range. According to the 2025 census results, the city's population has surpassed 3.7 million. As Iran's most important religious center, it hosts millions of domestic and international pilgrims annually. This demographic dynamism, along with the continuous flow of rural-urban migration, has placed significant pressure on the urban housing system in recent decades. Rapid population growth and limited formal housing supply have been instrumental in the expansion of informal settlements on the city's periphery, turning this process into a structural trend. According to Mashhad Municipality's plan for organizing informal settlements, approximately 30 to 32 percent of the city's population resides in such areas, a proportion that makes Mashhad one of the most extensive hubs of informal settlement in the country at the national level. A report by the Iranian Parliament Research Center (2022) also emphasizes that the number of marginalized residents in Mashhad exceeds the total population of four provinces in the country.

Mashhad's informal settlements have developed across 8 zones and 67 neighborhoods, covering an area of approximately 3,695 hectares. This area is

equivalent to about 10 percent of the city's total area and close to 6 percent of all marginalized zones in the country (Deputy of Planning and Human Capital Development, Mashhad Municipality, 2021). The spatial distribution of these zones shows a combined pattern of continuous and discontinuous fabrics, extending from the north, northwest, and west to the east and southeast of the city, creating dense population nuclei. Among these areas, the neighborhoods of Al-Teimour, Ghal'eh Sakhteman, Golshahr, Khajeh Rabi', Daravey, Old Quchan Road, Seyedi, and Sis Abad are recognized as the most significant and extensive centers of marginalization. The average population density in these nuclei is estimated at 236 persons per hectare, which shows a significant gap compared to the average density of Mashhad city (87 persons per hectare) and indicates the extra pressure on the infrastructure, urban services, and transportation networks of these areas (Iran Urban Regeneration Company, 2025).

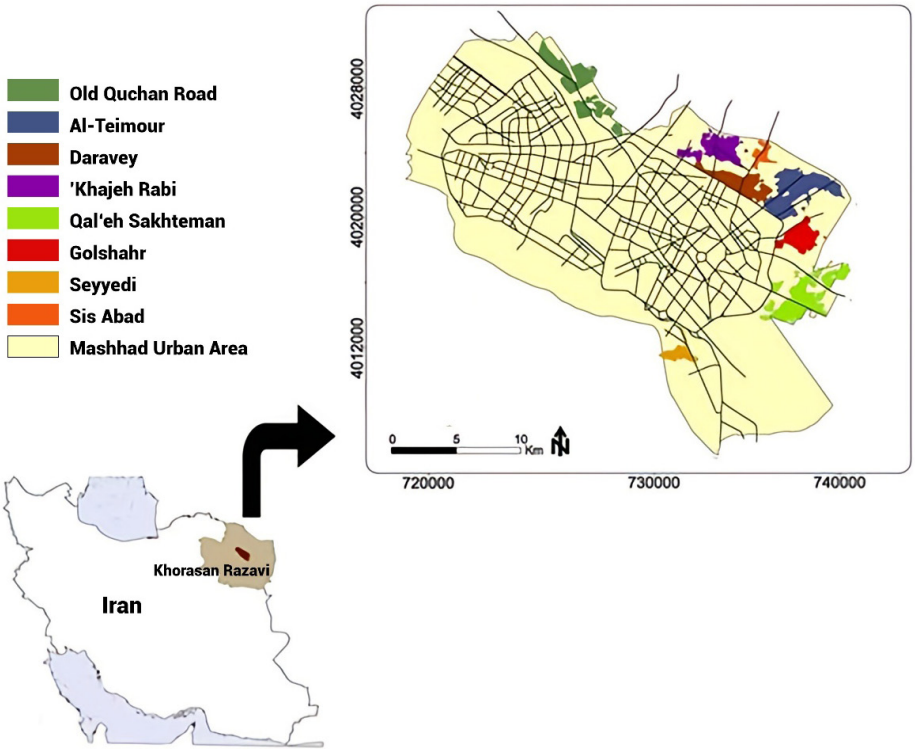


**Figure 2. Geographic location of the study area**

## 3.2. Research method

The present research, with an exploratory sequential mixed-methods approach and an applied-developmental nature, analyzes spatial justice and infill development in eight informal settlements of Mashhad. In the research design, the quantitative phase provides the initial measurement framework and zoning, and the qualitative phase reveals the causal and explanatory layers of the processes. The statistical population of the study consisted of four groups: The spatial units, the neighborhood residents, the urban experts, and the local leaders. The spatial units included eight informal settlement neighborhoods that were surveyed by the census. The initial sample size for the spatial justice measurement questionnaire was estimated to be 384 people using the Cochran formula (with a confidence level of 95%, estimation error of 0.05, and approximate variance of 0.25). This sample was distributed among the eight neighborhoods by a simple random method in proportion to the population of each neighborhood. Urban experts included 20 individuals to complete the pairwise comparison questionnaire for the ANP model and 15 individuals to conduct semi-structured qualitative interviews. The experts were selected through a purposive sampling method with maximum diversity based on the following criteria: having a master's degree or higher in related fields, at least 5 years of professional or research experience on informal settlements, spatial justice, or infill development in Mashhad, and willingness to participate (Creswell & Poth, 2018). Ultimately, 12

local leaders (4 from each of the three final selected neighborhoods) were selected for in-depth interviews. The selection method was a combination of purposive sampling and snowball sampling (Etikan et al., 2016). Initially, with the help of neighborhood councils and the introduction of local key figures, two to three recognized leaders in each neighborhood, who met the main criteria, were identified and interviewed. The criteria included residing in the neighborhood for at least 10 years and being known as someone knowledgeable about local issues. The individuals were asked to introduce other knowledgeable and influential people in the neighborhood with similar conditions. This process continued until theoretical saturation and relative balance in gender and age were achieved.

After the initial zoning of spatial justice in the eight neighborhoods, three key neighborhoods were selected for a deeper analysis of the relationship between spatial justice and the feasibility of infill development: Golshahr (severely deprived), Khajeh Rabi' (intermediate status), and Old Quchan Road (privileged).

To ensure the statistical adequacy of disaggregated analyses at the neighborhood level and to prevent any bias arising from reusing respondents from the first phase, a completely independent sample with a new sampling frame was conducted. The sampling frame for this phase was a new list of residents prepared through field visits and with the cooperation of each neighborhood council, having no overlap with the respondents from the first phase (384 individuals). The required sample size for each neighborhood, while maintaining a 95% confidence level and increasing the margin of error to 0.1 (due to the more exploratory nature of this phase), was estimated at 90 individuals. Therefore, using simple random sampling from this new frame, 90 questionnaires were completed in each of the three selected neighborhoods, resulting in a total of 270 independent questionnaires for neighborhood-based analyses. This approach, in which the sample for the qualitative/complementary phase is not a subset of the first-phase sample but is drawn from the same population with a new frame and re-selection, follows methodological recommendations for sequential mixed-methods designs to enhance validity (Creswell & Plano Clark, 2018).

Data were collected in two quantitative and qualitative phases. In the quantitative phase, spatial analyses were conducted in a GIS environment, and a researcher-made questionnaire was used to measure the five dimensions of spatial justice (spatial cohesion, access, environmental vibrancy, capacity, and compatibility). To determine indicator weights using the ANP method, a pairwise comparison questionnaire was distributed among 20 experts, and the consistency ratio (CR) of all matrices was calculated using Super Decisions software. All CR values were below 0.1, indicating reliable and consistent expert judgments. In the qualitative phase, semi-structured interviews were conducted with 15 experts, and in-depth interviews were held with 12 local leaders.

Data analysis was conducted in three steps. First, exploratory factor analysis confirmed the factor structure of the indicators with a KMO value of 0.87 and the significance of Bartlett's test at the 0.001 level. In the next step, the indicators' weights were determined using the ANP method, and the composite spatial justice index was calculated using the formula $SI = \sum (wi \times xi)$. Zoning maps were prepared in the GIS environment. Subsequently, the three key neighborhoods were extracted, and the infill development questionnaire was administered in each neighborhood (90 samples each) to collect disaggregated data. In the qualitative data processing, interview data were processed using thematic analysis and qualitative content analysis methods. The quantitative instrument reliability was confirmed with a Cronbach's alpha of 0.84. Content validity was confirmed by experts' opinions and CVR=0.75, and construct validity was confirmed by confirmatory factor analysis and appropriate fit indexes, including CFI=0.92, RMSEA=0.06, and $\chi^2/df=2.1$. To ensure the reliability of the qualitative analysis, Cohen's kappa coefficient of 0.78 was obtained. In the final stage, using an explanatory-sequential strategy, quantitative and qualitative findings were integrated; spatial justice maps were aligned with interview data, and this alignment led to the identification of causal mechanisms and the explanation of infill development patterns in informal settlements. All stages of the research were conducted in compliance with ethical principles, including informed consent, confidentiality of information, and preventing any harm to participants.

## 4. Findings

To analyze the socio-demographic characteristics of the studied neighborhoods, the data in Table 1 were first examined. This table provides a clear picture of the gender, age, income level, and housing status of residents in the informal settlements.

**Table 1. Demographic and social characteristics of respondents**

| Variable | Category | Count | Percentage | Remarks |
|---|---|---|---|---|
| Gender | Male | 216 | 56.2% | Male dominance in the sample |
| | Female | 168 | 43.8% | - |
| Age | Under 25 years | 58 | 15.1% | - |
| | 25-46 years | 173 | 45.1% | Highest frequency |
| | 47-66 years | 121 | 31.5% | - |
| | Over 67 years | 32 | 8.3% | - |
| Length of residence | Less than 5 years | 46 | 12.0% | - |
| | 5-15 years | 135 | 35.2% | - |
| | 16-25 years | 142 | 37.0% | Population stability |
| | Over 25 years | 61 | 15.9% | - |
| Marital status | Married | 298 | 77.6% | Dominance of married individuals |
| | Single | 77 | 20.1% | - |
| | Other | 9 | 2.3% | - |
| Education | Illiterate | 42 | 10.9% | Educational deprivation |
| | Elementary | 115 | 29.9% | Highest frequency |
| | Middle school | 97 | 25.3% | - |
| | High school | 86 | 22.4% | - |
| | University | 44 | 11.5% | - |
| Employment status | Employed | 207 | 53.9% | - |
| | Unemployed | 109 | 28.4% | High unemployment rate |
| | Homemaker | 47 | 12.2% | - |
| | Student | 21 | 5.5% | - |
| Monthly income (Toman) | Less than 12 million | 127 | 33.1% | Economic poverty |
| | 12-14 million | 185 | 48.2% | - |
| | 14-16 million | 54 | 14.1% | - |
| | Over 16 million | 18 | 4.7% | - |
| Housing tenure | Owned | 247 | 64.3% | Opportunity for renewal |
| | Rented | 123 | 32.0% | - |
| | Other | 14 | 3.6% | - |
| Household size | 1-3 persons | 103 | 26.8% | - |
| | 4-5 persons | 198 | 51.6% | Average household size |
| | Over 5 persons | 83 | 21.6% | - |

Data analysis reveals three prominent patterns in the social structure of the neighborhoods: First, a relatively balanced gender composition with a slight male dominance; second, a significant concentration of the population in the 25-46 age group, indicating the presence of an economically active yet vulnerable population; and third, low levels of education and income, which reinforce the urban poverty pattern and have direct implications for spatial justice. Additionally, although about two-thirds of households own their homes, a significant portion still live in unstable housing conditions.

To investigate the study's implicit hypothesis regarding the impact of socio-economic characteristics on residents' perception of spatial justice, statistical relationships between key demographic variables (education level and monthly income) and the average composite spatial justice index score were tested. Since both independent variables (literacy and income) were measured at the ordinal level, the non-parametric Kruskal-Wallis test was used. The results showed a statistically significant relationship between respondents' education level and their perceived spatial justice score ($\chi^2(4) = 21.37$, $p < 0.001$). Examination of mean ranks indicated that with an increase in education level (from illiteracy to university), the mean rank of perceived spatial justice also increased significantly. In other words, residents with higher education assessed their neighborhood's situation as more just in terms of service and opportunity distribution. Similarly, the relationship between monthly income level and perceived spatial justice was also significant ($\chi^2(3) = 15.89$, $p = 0.001$). Results showed that higher-income groups, on average, gave a higher score to spatial justice in their neighborhood. These findings confirm that educational and economic deprivations not only act as objective indicators of inequality but also affect residents' attitudes and subjective perception of their living space, deepening the perceptual gap between different social groups.

This significant relationship between education level and a more positive perception of spatial justice can be interpreted through theoretical frameworks of spatial and urban sociology. On the one hand, with increased education, individuals' cultural capital (in the Bourdieusian sense) and awareness of citizenship rights increase. This awareness elevates their standards and expectations regarding the quality of their living environment, access to services, and the distribution of resources in the city. On the other hand, and perhaps more importantly, higher education is usually associated with access to broader social networks, greater influence in local decision-making processes, and better ability for advocacy. These factors strengthen the sense of control and ownership over the living space. In light of Henri Lefebvre's theory of "the right to the city," residents with higher education are not merely passive consumers of space, but more active agents in the process of "producing space." They are better able to appropriate space in their favor, intervene in it, and therefore report less feeling of injustice, as they possess, to some extent, the individual and social tools to compensate for objective inequalities. In contrast, residents with lower education, due to deprivation of these very cultural and social capitals, are often marginalized in spatial production processes, and their inability to change environmental conditions can lead to a stronger perception of injustice. Therefore, the direct relationship between education and the perception of justice is not merely a reflection of differences in objective situation but indicates the decisive role of empowerment and individual agency in interpreting living space.

Before analyzing the objective indicators of spatial justice, the validity of the measurement tool was assessed. The results are presented in Table 2.

**Table 2. Reliability and validity indicators**

| Indicator | Value | Status |
|---|---|---|
| Overall Cronbach's Alpha | 0.84 | Desirable |
| Kaiser-Meyer-Olkin (KMO) | 0.87 | Desirable |
| Bartlett's test of sphericity | 0.001 | Significant |
| Content validity ratio (CVR) | 0.75 | Acceptable |
| Comparative fit index (CFI) | 0.92 | Desirable |
| Root mean square error of approximation (RMSEA) | 0.06 | Acceptable |
| Chi-square/degrees of freedom ($\chi^2$/df) | 2.1 | Acceptable |
| Cohen's Kappa (for interviews) | 0.78 | Desirable |

The findings indicate that the research instrument has desirable internal reliability (Cronbach's alpha = 0.84), appropriate sampling adequacy (KMO = 0.87), and acceptable construct validity. The fit indexes of the confirmatory model (RMSEA = 0.06 and CFI = 0.92) also provide the necessary confidence for subsequent

analyses. This step establishes the necessary foundation for entering conceptual and spatial analysis. In the next step, the general status of spatial justice in all neighborhoods was evaluated. Instead of presenting several separate tables, the five indicators were aggregated into one table (Table 3).

**Table 3. Mean and standard deviation of indicators (all neighborhoods)**

| Main indicator | Sub-criteria | Mean (Likert Scale) | Standard Deviation |
|---|---|---|---|
| Spatial cohesion | Proper location of urban services | 3.12 | 0.89 |
| | Proper population distribution | 2.87 | 0.92 |
| | Presence of factors linking the neighborhood and surroundings | 3.05 | 0.85 |
| | Observance of the access hierarchy | 2.96 | 0.88 |
| Access | Permeability | 2.82 | 0.87 |
| | Access to public services | 2.92 | 1.02 |
| | Appropriate access to urban infrastructure | 2.58 | |
| Environmental vibrancy | Service diversity | 2.92 | 0.87 |
| | Social security | 2.58 | 1.02 |
| Capacity | Presence of strong internal neighborhood connections | 3.21 | 0.83 |
| | Presence of environmental development potentials | 3.15 | 0.86 |
| | Structural safety and stability | 2.94 | 0.90 |
| Compatibility | Functional compatibility | 3.08 | 0.84 |
| | Compatibility with the natural environment | 3.25 | 0.79 |

Table 3 shows that the mean of most indicators is at a "medium" level. The two dimensions, "Capacity" and "Compatibility with the environment", are in a relatively better state; in contrast, "Access to public services" and "Social security" are in the lowest state. This preliminary picture indicates that spatial deprivation in informal settlements stems primarily from a lack of services and social insecurity rather than necessarily from physical weakness. After examining the overall status, a disaggregated analysis was conducted to identify neighborhood differences. Table 4 shows the mean of spatial justice indicators for each neighborhood.

**Table 4. Mean and standard deviation of spatial justice indicators by neighborhood**

| Neighborhood | Indicator | Mean | S.D. | Status |
|---|---|---|---|---|
| Old Quchan Road | Spatial cohesion | 4.07 | 0.89 | Highly desirable |
| | Access | 3.39 | 0.94 | Medium |
| | Environmental vibrancy | 2.52 | 0.95 | Undesirable |
| | Capacity | 3.55 | 0.86 | Desirable |
| | Compatibility | 3.04 | 0.82 | Medium |
| Khajeh Rabi' | Spatial cohesion | 3.51 | 0.89 | Desirable |
| | Access | 3.41 | 0.94 | Medium |
| | Environmental vibrancy | 2.68 | 0.95 | Undesirable |
| | Capacity | 3.49 | 0.86 | Desirable |
| | Compatibility | 2.41 | 0.82 | Undesirable |

| Neighborhood | Indicator | Mean | S.D. | Status |
|---|---|---|---|---|
| Sis Abad | Spatial cohesion | 1.97 | 0.89 | Highly undesirable |
| | Access | 2.35 | 0.94 | Undesirable |
| | Environmental vibrancy | 2.31 | 0.95 | Undesirable |
| | Capacity | 4.49 | 0.86 | Highly desirable |
| | Compatibility | 3.37 | 0.82 | Desirable |
| daravey | Spatial cohesion | 3.40 | 0.89 | Desirable |
| | Access | 4.31 | 0.94 | Highly desirable |
| | Environmental vibrancy | 2.32 | 0.95 | Undesirable |
| | Capacity | 2.16 | 0.86 | Undesirable |
| | Compatibility | 1.88 | 0.82 | Highly undesirable |
| Al-Teimour | Spatial cohesion | 2.40 | 0.89 | Undesirable |
| | Access | 3.89 | 0.94 | Desirable |
| | Environmental vibrancy | 2.37 | 0.95 | Undesirable |
| | Capacity | 1.95 | 0.86 | Undesirable |
| | Compatibility | 3.87 | 0.82 | Desirable |
| Golshahr | Spatial cohesion | 2.68 | 0.89 | Undesirable |
| | Access | 1.96 | 0.94 | Highly undesirable |
| | Environmental vibrancy | 1.96 | 0.95 | Highly undesirable |
| | Capacity | 2.33 | 0.86 | Undesirable |
| | Compatibility | 4.22 | 0.82 | Highly desirable |
| Ghal'eh Sakhteman | Spatial cohesion | 1.99 | 0.89 | Highly undesirable |
| | Access | 2.49 | 0.94 | Undesirable |
| | Environmental vibrancy | 3.49 | 0.95 | Desirable |
| | Capacity | 3.68 | 0.86 | Desirable |
| | Compatibility | 2.48 | 0.82 | Undesirable |
| seyedi | Spatial cohesion | 3.54 | 0.89 | Desirable |
| | Access | 3.35 | 0.94 | Medium |
| | Environmental vibrancy | 4.01 | 0.95 | Highly desirable |
| | Capacity | 1.40 | 0.86 | Highly undesirable |
| | Compatibility | 3.32 | 0.82 | Desirable |

Analysis of Table 4 suggests deep heterogeneity in the spatial structure of the neighborhoods. For example, the Old Quchan Road neighborhood is in a desirable state in "Spatial cohesion" and "Capacity," but has a serious weakness in "Environmental vibrancy." The Seyedi neighborhood, in contrast, has high vibrancy but lacks physical capacity. The Golshahr neighborhood is in a critical state in most indicators except for compatibility with the environment. This heterogeneity shows that spatial inequality in Mashhad is not only observable but also multi-dimensional and complex, with different neighborhoods experiencing different combinations of strengths and weaknesses.

Following the descriptive analysis, exploratory factor analysis (EFA) was used to identify the latent nature of the indicators. The KMO test (0.87) confirmed sampling adequacy, and Bartlett's test was significant.

**Table 5. Results of factor analysis and indicator loadings**

| Factor | Eigenvalue | % of Variance | Indicators and factor loadings | ANP relative weight |
|---|---|---|---|---|
| Spatial cohesion | 4.25 | 20.52% | Urban service location (0.423), population distribution (0.542), neighborhood linkage (0.532), access hierarchy (0.536) | 0.205 |
| Access | 3.38 | 16.32% | Permeability (0.623), public services (0.932), urban infrastructure (0.831), service diversity/ social security (0.843) | 0.229 |
| Environmental vibrancy | 3.01 | 14.54% | Service diversity (0.738), social security (0.585) | 0.146 |
| Capacity | 2.04 | 9.87% | Neighborhood connections (0.821), development potential (0.749), structural safety (0.749) | 0.228 |
| Compatibility | 1.57 | 7.59% | Functional compatibility (0.585), compatibility with natural environment (0.738) | 0.146 |

The five main factors explain 68.84% of the total variance. The weights are extracted from the F'ANP model, with the highest weights belonging to permeability, development potential, and structural safety.

Examination of the final weights extracted from the ANP model (Table 5) shows that the sub-criteria "Permeability" (in the access dimension) and "Structural safety and stability" (in the capacity dimension) have gained the highest relative weight among all sub-criteria. This prioritization by experts reflects two fundamental and simultaneous concerns in Mashhad's informal settlements. The priority given to "Permeability" (as the capability for easy, pedestrian-oriented access into and out of the neighborhood) indicates that the problem in these neighborhoods is not merely a lack of services; rather, "physical access" to existing services has become a structural barrier due to inefficient road networks, numerous dead ends, and poor-quality sidewalks. Qualitative data from interviews with residents and local leaders also confirm this, citing the lack of proper permeability as a factor for spatial isolation, increased daily transportation costs, and reduced social interactions. On the other hand, the high weight of "Structural safety and stability" (including building strength, earthquake resistance, and the absence of hazardous constructions) indicates that unsafe physical infrastructure looms as a fundamental threat to the livability and development potential of these neighborhoods. This concern is evident in the deteriorated, spontaneously built informal fabrics, often constructed outside technical supervision.

From the perspective of the "Urban resilience" framework, these two priorities can be interpreted as the foundations of physical resilience. The priority of structural safety is the most direct reflection of these fabrics' high vulnerability to natural hazards (especially earthquakes) and the urgent need to upgrade structural capacity. Without this component, any development will be fragile and unstable. The priority of permeability also plays a vital role in resilience; an efficient and continuous communication network is a prerequisite for rapid access of relief services in a crisis, safe evacuation, and distribution of resources in emergency situations. Therefore, the experts' weighting shows not only everyday concerns but also an intuitive understanding of the prerequisites for resilience.

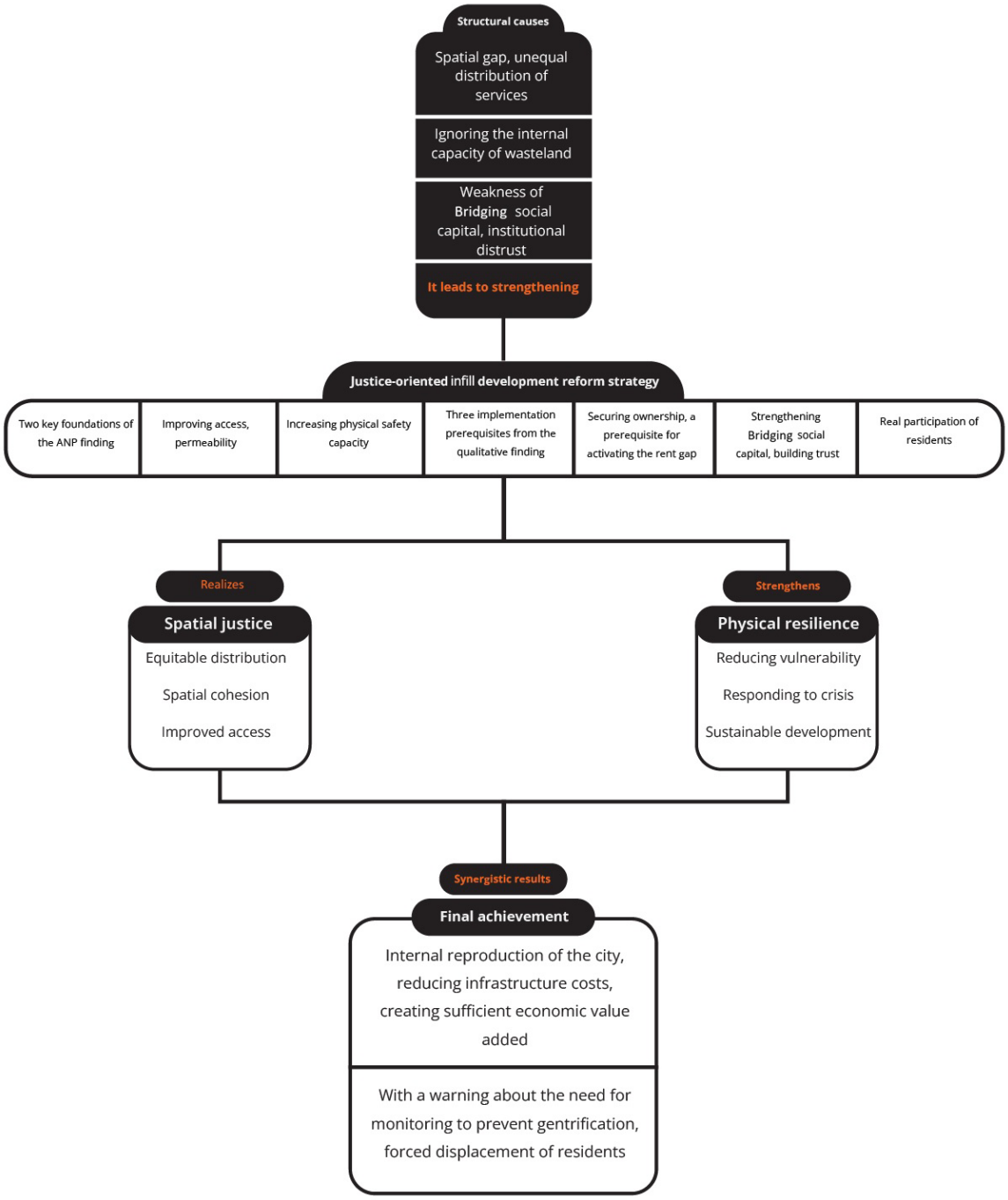


**Figure 3. Proposed visual model: A causal-strategic framework for spatial justice and infill development in informal settlements**

This diagram illustrates the causal path for achieving spatial justice and resilience in informal settlements. The core of this framework is a positive feedback loop between spatial justice and physical resilience. The explanation of why and how this loop forms directly relates to the findings of the ANP model and the qualitative analysis. The high weight of "Structural safety" in the ANP Model is a direct reflection of the structural causes identified in the model's first row. Weak bridging social capital (institutional distrust) and historical neglect of internal capacity have resulted in informal settlements with high physical vulnerability (unsafe buildings, lack of infrastructure). The high weight given to this indicator by experts indicates a consensus that "safety" is an indispensable prerequisite for any development. How this weight strengthens the feedback loop is where the model's corrective strategy comes into play. The high weight of

structural safety in the ANP means prioritizing resources for "increasing capacity/structural safety" (as one of the two key strategic foundations). Implementing this foundation strengthens the path (↓) towards physical resilience: By making structures safe, the neighborhood's physical resilience directly increases. It provides a precondition for spatial justice: A safe environment fosters trust (a qualitative precondition) and increases willingness to participate and invest in achieving just development. This realizes spatial justice (the arrow labeled "realizes"). It creates positive feedback: Realized spatial justice (with components such as improved access) in turn provides more resources and legitimacy for continuing and expanding investment in safety and resilience. Therefore, the initially high weight in the ANP is the fuel that sets this virtuous cycle in motion, strengthening both justice and resilience with each cycle. In summary, the high ANP weight for structural safety identifies a critical leverage point in the system. Investing in this point (according to the model's strategy) not only addresses an urgent need but, by activating a positive feedback loop with spatial justice, paves the way for achieving the outcome of a compact, just, and resilient city.

Consequently, from the experts' perspective, achieving any just infill development depends on overcoming two fundamental obstacles: "Opening up" the neighborhood by improving the permeability of the road network and "Securing" its physical fabric as a necessary precondition for any future intervention. This weighting guides policy-making away from a sole focus on "soft" dimensions (like participation) towards the essential integration of "hard" infrastructure (access and safety) with the goals of spatial justice and urban resilience. Furthermore, the significant weight allocated by experts to social indicators in the "Capacity" and "Spatial cohesion" dimensions (such as strong internal neighborhood connections and observance of access hierarchy) can be seen as reflecting their understanding of the importance of social infrastructure and bridging social capital essential for fostering participation and institutional trust-building alongside physical infrastructure.

After calculating the composite index using the arithmetic integration method ($\Sigma$ W_ANPj × S_Uij), neighborhoods were grouped into five main factors, and, based on hierarchical clustering, their level of spatial justice was determined. The detailed calculations of this process are presented in Table 6.

**Table 6. Composite index and neighborhood classification**

| Neighborhood | Spatial cohesion | Access | Vibrancy | Capacity | Compatibility | Composite index | Spatial justice level |
|---|---|---|---|---|---|---|---|
| Old Quchan Road | 1.07 | 0.39 | -0.043 | -0.48 | 0.55 | 1.57 | Very high |
| Khajeh Rabi' | 0.51 | 0.41 | -0.32 | 0.49 | -0.59 | 0.50 | Medium |
| Sis Abad | -1.03 | -0.65 | -0.69 | 1.49 | 0.37 | -0.51 | Low |
| Daravey | 0.40 | 1.31 | -0.68 | -0.84 | -1.12 | 0.42 | Medium |
| Al-Teimour | -0.60 | 0.89 | -0.63 | -1.05 | 0.87 | -0.52 | Low |
| Golshahr | -0.32 | -1.04 | -1.04 | -0.67 | 1.22 | -1.85 | Very low |
| Ghal'eh Sakhteman | -1.01 | -0.51 | 0.49 | 0.68 | -0.52 | -0.87 | Low |
| Seyedi | 0.54 | 0.35 | 1.01 | -1.60 | 0.32 | 0.62 | High |

Table 6 shows that the sum of each column equals the composite spatial justice index for each neighborhood. The results indicate that Old Quchan Road has the highest level of spatial justice, while Golshahr is at the lowest level. A gap of more than three units between these two neighborhoods creates a significant and meaningful divide for urban policymaking, highlighting the necessity for targeted intervention in less privileged neighborhoods.

After calculating the indexes, their spatial layers were generated in ArcGIS 10.8 software. To understand the spatial findings, maps of the five factors and the final spatial justice map were drawn. Each map displayed one dimension of spatial justice.

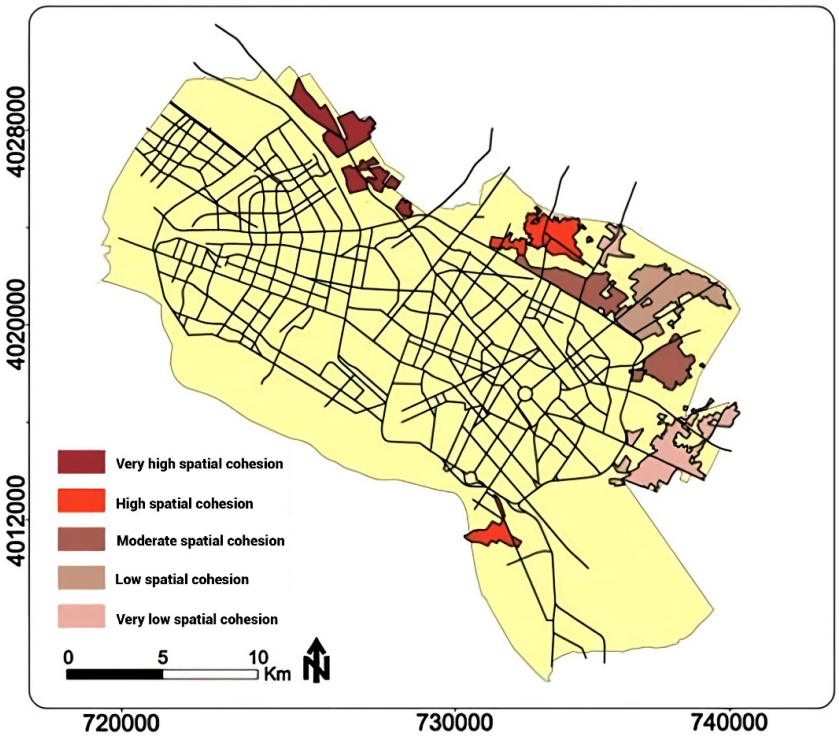


Figure 4. Spatial cohesion factor in informal settlements

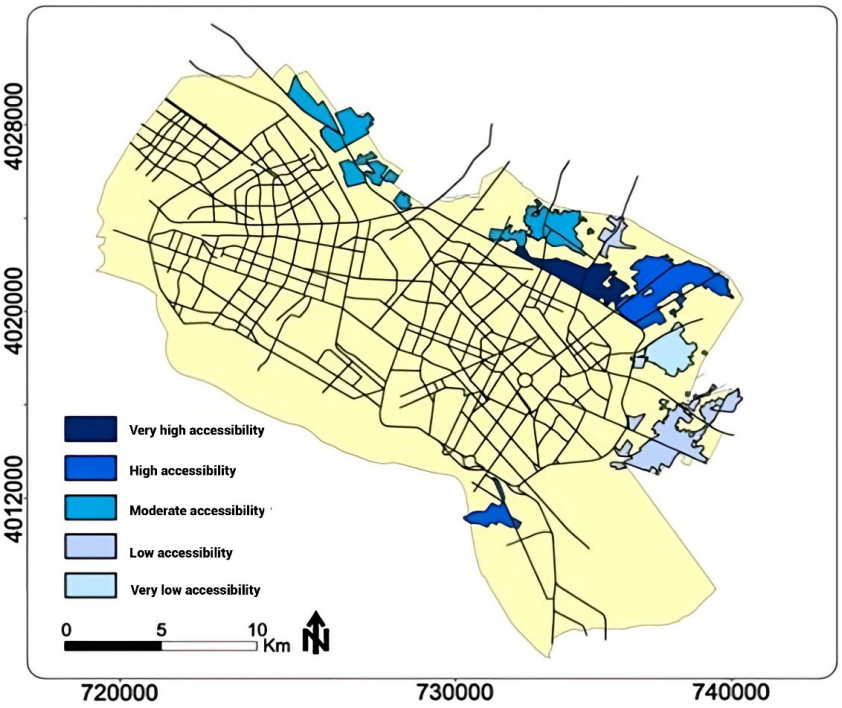


Figure 5. Access factor in informal settlements

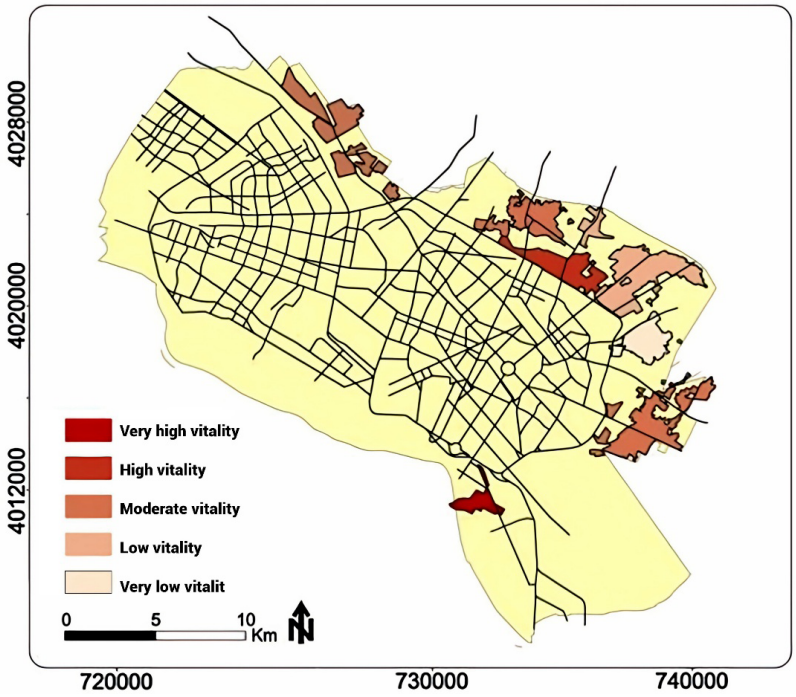


Figure 6. Level of vibrancy factor in informal settlements

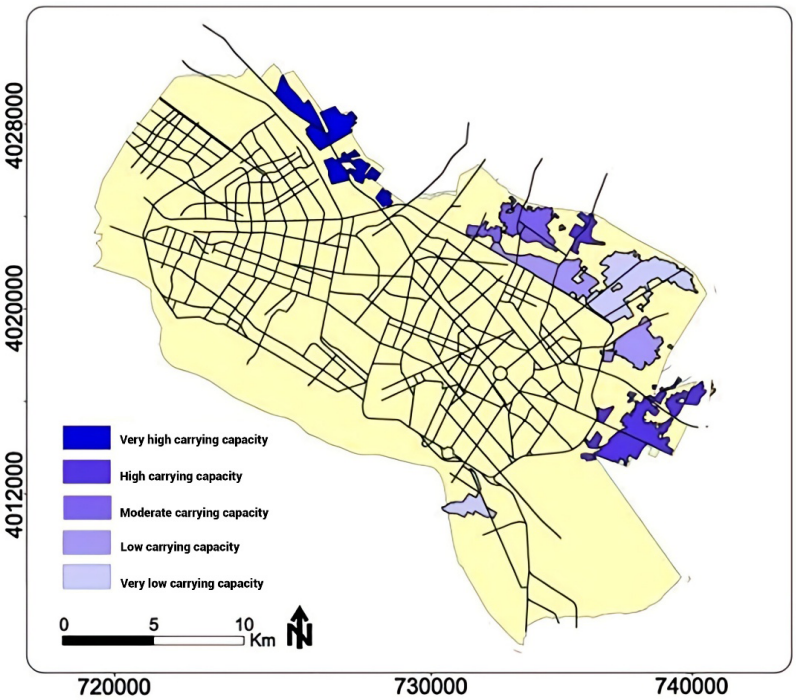


Figure 7. Capacity factor in informal settlements

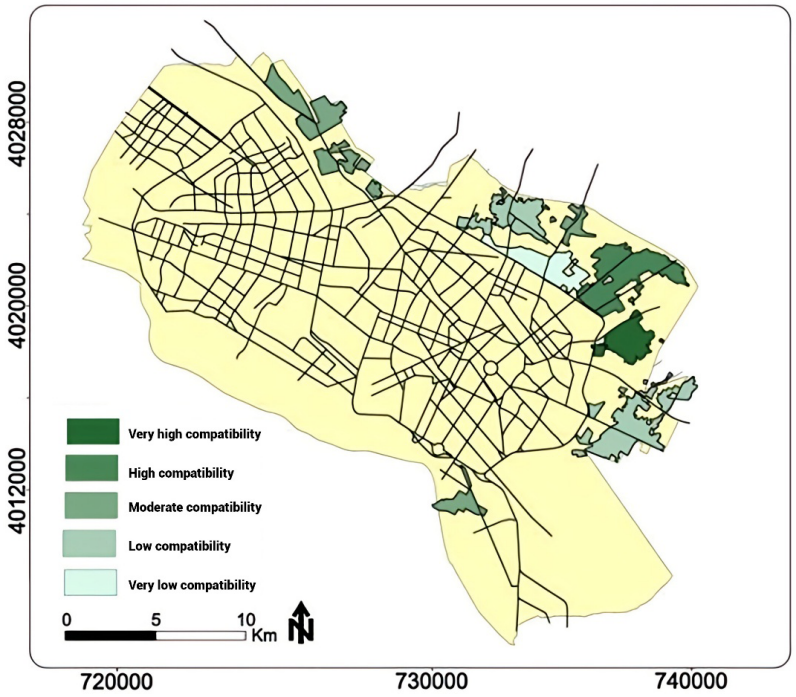


Figure 8. Level of compatibility factor in informal settlements

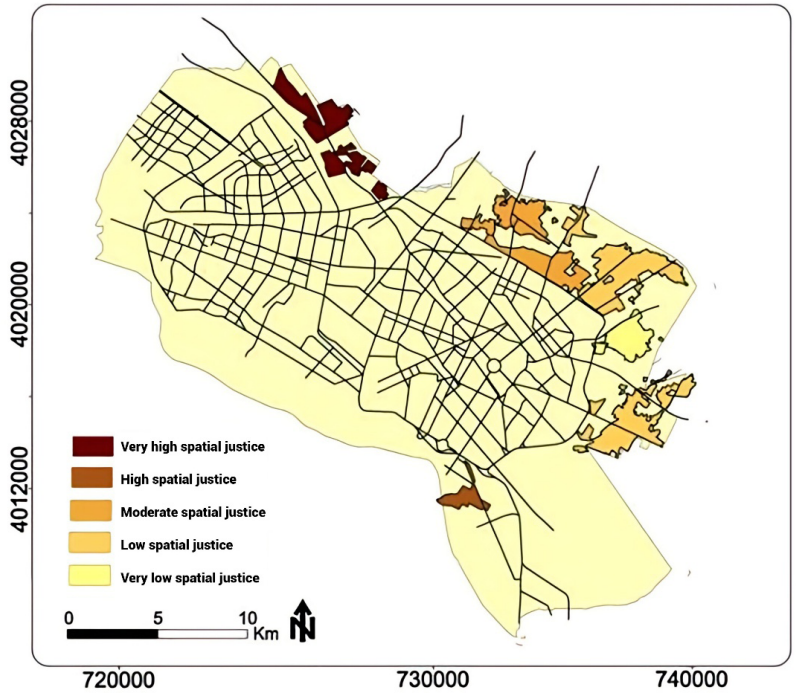


Figure 9. Level of spatial justice privilege in informal settlement zones

Visual analysis of the maps and their alignment with the ground realities of Mashhad reveals a clear spatial pattern of inequality. The main centers of spatial deprivation are concentrated in the eastern and northeastern parts of the study area, in neighborhoods such as Golshahr, Sis Abad, and Ghal'eh Sakhteman. These neighborhoods are generally located in more remote fringes of the city and, as the field data also showed, suffer from severe weaknesses in access to the main urban transportation network and the distribution of basic services. In contrast, a relatively more favorable situation is observed in the northern

and northwestern parts, particularly in the Old Quchan Road neighborhood. This neighborhood benefits from a locational advantage due to its proximity to a major communication axis (Quchan Road) and easier access to employment centers and urban services, which is confirmed by its highest ranking in spatial justice. An interesting pattern is observed in the Seyedi neighborhood, which, despite high environmental vibrancy (likely due to the presence of active local and commercial uses), experiences a drop in its final score due to physical problems and low capacity. This spatial analysis clearly shows that spatial justice in Mashhad's informal settlements is not only imbalanced but also highly place-specific and dependent on the geographical location and specific physical-functional characteristics of each neighborhood.

To understand the internal relationships among the factors of spatial justice, a correlation matrix was calculated. The correlation matrix is presented in Table 7.

**Table 7. Correlation matrix between main indicators**

| Indicator | Spatial cohesion | Access | Environmental vibrancy | Capacity | Compatibility |
|---|---|---|---|---|---|
| Spatial cohesion | 1.00 | | | | |
| Access | 0.68 | 1.00 | | | |
| Environmental vibrancy | 0.54 | 0.72 | 1.00 | | |
| Capacity | 0.49 | 0.35 | 0.28 | 1.00 | |
| Compatibility | 0.32 | 0.41 | 0.56 | 0.19 | 1.00 |

This matrix shows that spatial cohesion, access, and environmental vibrancy have the highest correlations, and improving any one of these factors can have a positive effect on the others.

Neighborhoods were classified into four clusters based on the composite index, and a proposed intervention strategy was specified for each cluster (Table 8).

**Table 8. Clustering of neighborhoods based on spatial justice indicators**

| Cluster | Neighborhoods | Indicator characteristics | Intervention |
|---|---|---|---|
| Cluster 1 (privileged) | Old Quchan Road, Seyedi | High spatial cohesion, proper access | Sustainable development, modeling |
| Cluster 2 (medium) | Khajeh Rabi', Daravey | Relative balance in indicators | Quality of life enhancement |
| Cluster 3 (deprived) | Sis Abad, Al-Teimour, Ghal'eh Sakhteman | Shortage in access and vibrancy | Fundamental interventions |
| Cluster 4 (very deprived) | Golshahr | Severe shortage in all indicators | Immediate and comprehensive interventions |

This clustering forms the basis for decision-making and regional policy, showing that Golshahr requires immediate intervention, Sis Abad and Al-Teimour require structural reforms, and privileged neighborhoods are suitable for modeling.

To examine the capacity for infill development, a questionnaire was administered in three selected neighborhoods (Golshahr, Khajeh Rabi', and Old Quchan Road). The results are summarized in Table 9.

**Table 9. Infill development indicators in three neighborhoods**

| Infill development indicator | Golshahr (deprived) | Khajeh Rabi' (medium) | Old Quchan Road (privileged) | Analysis |
|---|---|---|---|---|
| Willingness to participate | 2.1 | 3.4 | 4.3 | Participation gap |
| Access to vacant land | 3.8 | 2.9 | 2.2 | Inverse physical potential |
| Feasibility of mixed use | 1.9 | 3.2 | 4.1 | Development feasibility |
| Potential for density increase | 2.3 | 3.5 | 3.8 | - |

| Infill development indicator | Golshahr (deprived) | Khajeh Rabi' (medium) | Old Quchan Road (privileged) | Analysis |
|---|---|---|---|---|
| Level of social capital | 3.5 | 3.8 | 4.4 | Development driver |
| Access to existing infrastructure | 1.7 | 3.6 | 4.5 | Infrastructure gap |

The results show that Golshahr, despite having abundant vacant land, has the lowest capacity for infill development due to weak infrastructure and low social capital. Old Quchan Road, with strong social capital and infrastructure, is the most suitable neighborhood for infill development. The relationship between the two concepts of spatial justice and infill development is presented as a correlation in Table 10.

**Table 10. Correlation matrix of spatial justice and infill development**

| Spatial justice indicator | Correlation with infill development | Significance level |
|---|---|---|
| Access | 0.78 | $p < 0.01$ |
| Environmental vibrancy | 0.72 | $p < 0.01$ |
| Spatial cohesion | 0.65 | $p < 0.05$ |
| Capacity | 0.58 | $p < 0.05$ |
| Compatibility | 0.43 | $p < 0.10$ |

The analysis indicates that "Access" has the highest correlation with infill development, and implementing infill development programs will be practically unsuccessful without improving infrastructure and access.

The final qualitative sample composition exhibited desirable diversity. Among the 15 interviewed experts were 7 women and 8 men, aged 35 to 60, from various professional backgrounds. The sample of 12 local leaders included 5 women and 7 men, aged 40 to 70, all with a long history of residence in the relevant neighborhoods. This diversity in sample composition enabled the collection of a wider range of perspectives. Previous quantitative analyses set the stage for precise questioning and qualitative investigation. To understand the roots of differences in spatial justice and infill development, the perceptions of experts and local leaders were examined.

**Table 11. Main themes from interviews with 15 experts**

| Main theme | Key codes | Frequency | Representative quote |
|---|---|---|---|
| Role of urban governance | Weak inter-agency coordination, centralization, and a lack of an operational plan | 12 | "Each agency has its own separate direction." |
| Institutional barriers | Complex bureaucracy, lack of transparency, and administrative corruption | 11 | "Projects get lost in administrative red tape." |
| Unbalanced development pattern | Attention to showcase projects, neglect of deprived neighborhoods | 14 | "Only the city's facade is important; the periphery is forgotten." |
| Lack of structured participation | Disregard for local knowledge, participatory formalism | 13 | "They inform the people only at the final stage." |

**Table 12. Comparative analysis of the views of 12 local leaders in three neighborhoods**

| Neighborhood | View on infill development | Perceived barriers | Identified opportunities | Analysis |
|---|---|---|---|---|
| Golshahr | Distrust of formal institutions, fear of forced displacement | Lack of tenure security, absence of basic services | Vacant lands, young workforce | Resistance to change |
| Khajeh Rabi' | Optimistic but cautious, expectation of government support | Lack of funding, weak social networks | Suitable location, acceptance of migrants | Dependence on institutions |
| Old Quchan Road | Active and spontaneous, local initiative | Restrictive regulations, height limitations | Strong social capital, access to the local market | Spontaneous development |

The interviews showed that weak institutional coordination, complex bureaucracy, and the lack of structured participation are among the primary obstacles. Local leaders also emphasized tenure security, basic services, and trust-building. To ensure the coherence of the results, quantitative and qualitative data were triangulated.

**Table 13. Integration of quantitative and qualitative findings**

| Quantitative finding | Qualitative finding | Integrated result |
|---|---|---|
| Low willingness to participate in Golshahr | Historical distrust of formal institutions | Need for trust-building before any intervention |
| High social capital in Old Quchan Road | Culture of self-organization and mutual aid | Potential for modeling for other neighborhoods |
| High physical potential in Golshahr | Local knowledge of usable lands | Prioritizing interventions based on local capacities |
| Access gap in deprived neighborhoods | Systematic institutional neglect | Distributive justice |

Comparison of findings showed that the low willingness to participate in Golshahr is explained by institutional distrust, and the findings are fully consistent. The combined data analysis revealed three main patterns: Cyclical deprivation, fragile balance, and virtuous cycle.

**Table 14. Identified patterns**

| Pattern | Quantitative evidence | Qualitative evidence | Overall implication |
|---|---|---|---|
| Cyclical deprivation | Spatial justice: -1.85 in Golshahr | Structural distrust | Need for fundamental intervention |
| Fragile balance | Spatial justice: 0.50 in Khajeh Rabi’ | Expectation of external support | Need for facilitative development |
| Virtuous cycle | Spatial justice: 1.57 in Old Quchan Road | Local self-reliance | Potential for modeling |

**Table 15. Discovered relationships between variables**

| Relationship | Test type | Strength (coefficient) | Statistical details | Sig. Level | Implication |
|---|---|---|---|---|---|
| Spatial justice ↔ infill development | Pearson correlation | $r = 0.78$ | $t(382)=15.42$, 95% CI [0.73, 0.82] | $p < 0.001$ | A strong, direct, and statistically significant relationship. Increased spatial justice is associated with higher infill development feasibility. |
| Social capital → willingness to participate | Linear regression | $\beta = 0.76$ | $F(1,268)=185.3$, $R^2=0.58$ | $p < 0.001$ | Social capital is a powerful predictor of willingness to participate, confirming its role as a key mediating variable. |
| Access → mixed use | Pearson correlation | $r = 0.82$ | $t(382)=18.91$, 95% CI [0.78, 0.85] | $p < 0.001$ | Improving access indicators is a fundamental prerequisite for achieving mixed-use and functional dynamism in the neighborhood. |

Overall interpretation: The strong and significant association between spatial justice and infill development ($r = 0.78$, $p < 0.001$) is the most important finding in this section, strongly confirming the main hypothesis of the research. Based on the integrated results, neighborhoods were specified according to intervention priority.

**Table 16. Infill development scenarios and neighborhood prioritization**

| Priority | Neighborhood | Prioritization score | Proposed intervention type | Key actions |
|---|---|---|---|---|
| 1 | Golshahr | 9.2 | Comprehensive & immediate | Trust-building, basic services, tenure regularization |
| 2 | Sis Abad | 7.8 | Improving access & services | Improving access, enhancing vibrancy |
| 3 | Al-Teimour | 7.5 | Enhancing environmental vibrancy | Enhancing environmental vibrancy |
| 4 | Ghal'eh Sakhteman | 6.9 | Physical | Safety improvements and rehabilitation |
| 5 | Khajeh Rabi' | 5.2 | Infill development | Incentives and facilitation |
| 6 | Daravey | 4.8 | Optimization | Land use optimization |
| 7 | Seyedi | 3.5 | Preservation | Maintenance |
| 8 | Old Quchan Road | 2.1 | Modeling & sustainable Dev. | Networking and transferring experience |

The key conclusion is that interventions must be neighborhood-based and prioritized.

### 4.1. Hypothesis testing

Hypotheses were tested by combining quantitative data, including spatial justice indicators, correlation analysis, and ANP model weights, and qualitative evidence from observations and interviews.

Hypothesis 1, concerning the existence of severe spatial inequality in informal settlements, was confirmed. The composite spatial justice index has a range of 3.42 units (-1.85 to 1.57), with the greatest variation related to Access (0.94), followed by Spatial cohesion (0.89) and Capacity (0.86). Field data also shows that the neighborhoods Golshahr and Ghal'eh Sakhteman have the lowest access scores, while the neighborhoods Old Quchan Road and Seyedi have the highest spatial cohesion.

Hypothesis 2, claiming that access and spatial cohesion are the most important factors explaining spatial justice, was partially confirmed. The ANP shows that "Access" ranks first with a weight of 0.229, but "Spatial cohesion", with a weight of 0.205, comes after "Capacity" (0.228).

Hypothesis 3, regarding the differing origins of constraints on infill development in deprived versus privileged neighborhoods, was confirmed. Golshahr, with an infrastructure score of 1.7, is primarily constrained by a lack of services and weak social capital, whereas Old Quchan Road, with an infrastructure score of 4.5, is more constrained by land management and land-use regulation.

Hypothesis 4, concerning the significant and directional relationship between spatial justice and the feasibility of infill development, was fully confirmed. A correlation coefficient of 0.78 ($p < 0.01$) indicates a strong link between these two variables. Spatial justice correlates with participation at 0.76 and with the feasibility of mixed use at 0.82. Deprived neighborhoods, despite their higher average of vacant land (3.8), have lower participation (2.1).

Hypothesis 5 was also coconfirmed, showing that combining spatial justice policies with infill development is the most effective strategy for sustainable urban growth, which could improve the spatial justice index by approximately 0.5 units over three years. This is an estimate under static conditions, and housing market dynamics may yield different results.

In total, four hypotheses were fully confirmed, and one hypothesis was partially confirmed. The overall results indicate that spatial justice and infill development have a structural, bidirectional, and mutually reinforcing relationship, and enhancing one without the other will not lead to sustainability. This point forms the foundation of the article's final analyses and is linked to a deeper understanding of the discussion and conclusion.

## 5. Discussion and interpretation of findings

Analysis of the research findings reveals that spatial justice is unequally distributed in Mashhad's informal settlements, with significant differences between privileged and deprived neighborhoods in key spatial justice indicators. These differences, especially in access, spatial cohesion, and capacity, reflect the impact of institutional structures and the infrastructural and social disparities among neighborhoods. These results align with the theoretical framework of the literature review, which views spatial justice beyond the mere distribution of amenities and directly linked to local participation, access to power, and decision-

making (Dadashpoor & Dehghan, 2025; Capra-Ribeiro, 2024). Specifically, deprived neighborhoods face a lack of infrastructure, low environmental vibrancy, and social fragmentation, while privileged neighborhoods, with high spatial cohesion and social capital, could experience spontaneous and justice-oriented infill development. These findings align closely with similar domestic studies, including Rezaee et al. (2025) and Saberi et al. (2024), which have identified structural deprivation and "systemic failure" in planning institutions as the main drivers of spatial differences.

Analysis of indicator weights using the ANP model shows that Access and Capacity play a decisive role in realizing spatial justice, with Spatial cohesion having complementary importance. This result is consistent with the international literature on infill development (Ghodsi et al., 2021; Jun et al., 2024) and emphasizes that the success of infill development requires targeting the structural constraints of neighborhoods while strengthening their internal capacities. In this regard, the methodological innovation of the present research is also notable; integrating quantitative analysis of spatial justice with qualitative data and weighting indicators has enabled the prioritization of neighborhoods for infill development interventions—an approach less seen in previous domestic studies.

One prominent pattern identified by the research is the cycle of deprivation in neighborhoods like Golshahr. Lack of access, weak social capital, and infrastructural limitations constrain infill development and perpetuate deprivation. In contrast, privileged neighborhoods like Old Quchan Road, with strong social capital and efficient land management, exemplify a virtuous cycle where infill development can be self-reinforcing. This comparative analysis aligns with similar international studies (Schwab, 2018; Rigon, 2022) and shows that local participation and a focus on upgrading infrastructure are prerequisites for the justice-oriented success of infill development.

The present study, through triangulation of quantitative and qualitative data, reveals deeper mechanisms. Qualitative data from interviews with residents and local leaders in deprived neighborhoods indicate a profound "institutional distrust" towards formal planning and implementation bodies. This distrust is rooted in the historical experience of uncompensated demolitions, unfulfilled promises, and the lack of real participation in decision-making processes.

Within the framework of social capital theory (Putnam, 2015; Coleman, 1988), this situation can be analyzed by the crucial distinction between two types of social capital: on the one hand, bonding social capital, based on strong ties, solidarity, and trust within a homogeneous group (neighbors, relatives), which is generally high in informal settlements for survival and mutual support; on the other hand, bridging social capital, which pertains to weaker but vital connections between different social groups and formal institutions. The findings indicate severe erosion of this bridging social capital, which links formal institutions to the local community. The loss of this bridge and trust significantly increases transaction costs for any future interaction and cooperation. In other words, the presence of strong bonding capital does not compensate for the absence of bridging capital, and this gap keeps the neighborhood isolated and in structural deprivation.

This qualitative finding explains the high statistical correlation observed in the quantitative data between "social capital" and "willingness to participate" ($\beta = 0.76$). Considering Putnam's theoretical distinction, this strong relationship can be attributed mainly to the lack of bridging social capital and weak trust in formal institutions. In other words, the weakness of social capital in these neighborhoods, which itself stems from a historical institutional failure, specifically erodes the capital needed to collaborate with external institutions and, consequently, drastically reduces the willingness to participate in formal development projects, even while bonding capital may still exist for informal mutual aid within the neighborhood.

Therefore, any infill development strategy, before any physical action, requires rebuilding trust through transparency, tenure security, and genuine resident participation. From an economic perspective, this distrust reduces residents' incentive to invest in housing renovation and upgrading, as they anticipate an uncertain and high-risk cost-benefit ratio. Consequently, it artificially suppresses the economic value of land and properties in these neighborhoods and weakens the potential for utilizing market mechanisms for inner-city development.

From the perspective of urban political economy, this situation can be analyzed using Neil Smith's "rent gap" theory. This theory posits that the gap or distance between the current economic value of land (actual ground rent) and the potential value it could have under its "highest and best use" (potential ground rent) is the primary engine for attracting capital and urban renewal (Smith, 1987). In the studied informal

settlements, the actual ground rent is severely suppressed. Here, the most important factor for this suppression is “tenure insecurity” (lack of formal title, fear of demolition and displacement), which makes the risk of any investment unacceptable. Weak services and institutional distrust also exacerbate this situation. In contrast, the potential ground rent of these lands, due to their inner-city location and possibility of more efficient uses, is considerable, creating an attractive rent gap. Infill development, aimed at reducing spatial inequality, is precisely designed to close this rent gap. The core of this strategy, before any physical intervention, is establishing legal security and guaranteeing tenure for residents. Only under the umbrella of this security can complementary interventions, such as improving infrastructure and environmental quality, increase the actual ground rent toward its potential.

However, critical urban studies literature warns that activating the rent gap, especially in inner-city areas with high locational value, can carry the risk of gentrification and forced displacement of low-income residents (Lees et al., 2023; Slater, 2006). Herein lies the paradox of spatial justice: How can the market mechanism (the rent gap) be harnessed to improve conditions for the deprived, without that very mechanism becoming a tool for their exclusion? The answer to this research lies in the absolute prioritization of tenure security and fundamental resident participation. An infill development strategy leads to justice only when the increase in land value becomes not a pretext for dispossession but a tool for the financial empowerment of existing residents. This requires mechanisms for redistributing benefits (such as sharing in renewal proceeds) and strict anti-displacement regulations.

To ensure this outcome and adhere to ethical considerations, specific practical solutions are essential: promoting cooperative housing models or community development corporations that enable collective ownership and profit; mandating a share of price-controlled housing units in every project to preserve housing opportunities for low-income residents; granting preemptive purchase rights and financial incentives to existing residents; and establishing joint oversight bodies for transparency and accountability. Without this supportive and distributive framework, infill development in informal settlements can easily serve the accumulation of capital by external groups and exacerbate the initial injustice. Therefore, justice in process (guaranteeing tenure and participation) and justice in outcome (distributing benefits and preventing displacement) are two sides of the same coin; neglecting either undermines the entire spatial justice project.

Once this process begins, it stimulates private investment incentives (both by residents and developers) and the proceeds from increased land value can finance part of the renewal costs. Thus, spatial justice and infill development are not only a social necessity but also a smart economic opportunity to remove legal barriers, revitalize stagnant urban capital, and channel surplus capital towards the inner-city reproduction.

Third, achieving spatial justice through infill development requires a frank confrontation with the “political economy of space.” This study’s findings, regarding the concentration of deprivation in specific neighborhoods (e.g., east and northeast Mashhad) and the unequal distribution of public investments, can only be fully explained by analyzing power structures and urban rents. As Harvey (2008) and Soja (2010) have argued, spatial injustice is the product of processes of dispossession, capital accumulation, and political decisions that recreate space in favor of specific groups. In Mashhad, we can assume that locational rent from cheap peripheral lands and large-scale development projects has historically diverted planning attention and investment away from inner-city informal fabrics. As a redistributive strategy, infill development can overcome these relations only by simultaneously placing the transparency of land allocation and rent processes and the strengthening of community-based oversight institutions on the agenda. Without this political approach, there is a risk that even seemingly justice-oriented infill projects could be co-opted by the same prior rentier logic and become a factor for displacing residents and resettlement.

Spatial analysis of the findings also shows that prioritizing neighborhoods based on weighted indicators provides an efficient strategy for urban planning. Deprived neighborhoods require immediate and comprehensive interventions; medium-level neighborhoods need facilitation and development incentives; and privileged neighborhoods can take on the role of modeling and transferring experience. This comparative framework aligns with domestic studies (Saeedi Mofrad et al., 2020, 2021; Afsari et al., 2021), demonstrating that infill development is only effective when integrated with institutional, social, and spatial approaches. A direct economic consequence of this

prioritization is the optimal allocation of public resources. Targeted investment in the infrastructure of deprived neighborhoods (e.g., improving roads and service networks) not only realizes justice but, by reducing future service delivery costs and preventing the high expenses of horizontal expansion onto new lands, leads to macroeconomic savings for urban management in the long run. Increased spatial justice, by enhancing quality of life and investment security, can also increase the added value of land in these neighborhoods and strengthen the local tax base.

From an innovation perspective, this research has examined four key areas—urban growth patterns, spatial justice, infill development, and informal settlements—in an integrated and systematic manner. This causal and integrated framework shows that spatial justice is not only an independent goal but also a precondition and tool for the success of infill development. Unlike previous studies that examined each area separately, this study, using novel quantitative measures and qualitative criteria, including infrastructure capacity and inner neighborhood potential, provides a localized, scientific model for spatial-social planning in informal settlements.

Considering the framework of complex adaptive systems (CAS), it must be emphasized that the linear analytical models used in this research (such as correlation and regression), although limited in simulating nonlinear dynamics and complex interactions, serve as a "valid first-order approximation." The value of this approach lies in its ability to identify and quantify the direction and strength of key structural relationships (such as the positive and strong relationship between spatial justice and infill development feasibility) at a specific point in time. This identification provides an essential basis for any more complex future modeling. In other words, the present linear model provides a simplified but reasoned relational map of the system sufficient for designing macro strategies and prioritizing interventions. However, for long-term policy-making, risk management, and understanding unintended consequences in a dynamic system, moving towards dynamic modeling methods, such as agent-based modeling (ABM), which can simulate the behavior of various actors and the system's evolution over time, will be a complementary and necessary step. At the same time, the present study has significant limitations. The data are based on one city and a limited sample, and the generalizability of findings to other cities with different characteristics requires complementary studies. Furthermore, complex interactions among social, institutional, and spatial factors may encompass dimensions overlooked in purely quantitative analysis. However, the combination of quantitative and qualitative data in this research has largely enabled multi-dimensional and policy-oriented analysis and is a necessary step towards understanding this complex system.

In summary, the findings show that infill development and spatial justice have a bidirectional, reinforcing relationship, and the success of sustainable urban planning in informal settlements requires integrating spatial, institutional, and social approaches. This result, while aligned with the scientific background, fills a gap in previous studies on integrated planning for deprived neighborhoods and infill development, offering a practical and theoretical achievement for urban policymakers and planners. The final emphasis is that spatial justice is a public good whose realization, in addition to ethical justification, has a strong economic rationale. Concentrating development in the city prevents the wastage of massive investments in dispersed peripheral development and strengthens the foundations of a coherent, efficient, and resilient urban economy.

## 6. Conclusion

The present research comprehensively demonstrated that spatial justice in Mashhad's informal settlements is unequally distributed, with the greatest fluctuations observed in the indicators of access, spatial cohesion, and capacity. Integrated analysis of quantitative and qualitative data revealed that privileged neighborhoods, with appropriate access and high social capital, could implement infill development spontaneously, sustainably, and in a justice-oriented manner, while deprived neighborhoods, constrained by infrastructural limitations, weak social networks, and historical distrust, face serious obstacles in realizing infill development. This situation is the result of three key structural deficiencies in Mashhad's urban growth pattern highlighted by the findings: (1) a deep spatial gap between privileged and deprived neighborhoods, (2) neglect of the city's internal capacities (such as vacant and underutilized lands), and (3) the weakening of social capital and limitation of participation in informal fabrics. These deficiencies emphasize that the physical distribution of amenities forms only part of spatial justice, and decision-making processes, institutional coordination, and leveraging

local neighborhood capacities play a decisive role in achieving spatial justice and sustainable development. As a key achievement, this research provides an integrated causal framework linking urban growth patterns, spatial injustice, and infill development. It identifies the urban growth pattern as the primary cause, spatial injustice as the effect, and infill development as the corrective strategy. This framework, built upon the three aforementioned deficiencies, enables the prioritization of neighborhoods, assessment of internal capacities, and design of targeted interventions; it shows that infill development, without simultaneous attention to infrastructure, social capital, and local participation, can reproduce inequality.

To provide a quantitative picture of this strategy's potential, a plausible scenario was presented based on the research findings. Understanding this potential requires acknowledging that urban systems are complex adaptive systems (CAS) (Batty, 2008; Portugali, 2024). Relationships within these systems are inherently nonlinear, path-dependent, and subject to the reciprocal feedback of social, economic, and spatial factors. Considering this framework and aware of the inherent limitations of linear modeling, we can estimate, by combining two data sources, that the successful implementation of a model project could add approximately 0.5 units to the composite spatial justice index of a deprived neighborhood over three years. The data sources include: (1) the intensity of the relationship observed in the quantitative model (correlation coefficient r = 0.78 between spatial justice and infill development feasibility), and (2) qualitative expert estimates of the expected improvement in key indicators under conditions of relative stability of other variables. This amount is equivalent to closing about half of the gap between the current and desired status on the scale of this research. This estimate is not a definitive prediction, but rather an illustration of the direction and capacity for change in a simplified scenario. From this perspective, the present linear model can be considered a valid "first-order approximation" for outlining the key structural relationship and estimating initial effects. Practical results may vary due to unpredictable market dynamics, political changes, and complex social interactions. Therefore, although this model is useful for initial understanding and strategy design, long-term policy-making and risk management in this complex system require more dynamic models, such as agent-based modeling (ABM), which can simulate nonlinear interactions and unintended consequences.

Comparative analysis of the findings with domestic and international studies indicates that the structure of deprivation in neighborhoods like Golshahr aligns with a cycle of deprivation and infrastructural constraints, low social capital, and institutional distrust, while privileged neighborhoods exemplify a virtuous cycle and successful self-reliance. This convergence with domestic (Rezaee et al., 2025; Saberi et al., 2024) and international (Schwab, 2018; Rigon, 2022) research shows that local participation and infrastructure upgrading are prerequisites for the justice-oriented success of infill development, and intervention design must be based on these principles.

Realizing this strategy, in addition to social and physical justification, has a solid economic rationale. First, infill development, by preventing dispersed urban expansion onto virgin peripheral lands, leads to massive savings in the costs of constructing new infrastructure (water, electricity, gas, roads). Second, revitalizing vacant and deteriorated inner-city lands creates significant economic added value for the city, which can be captured through increased density yields and taxes on land and improvements. Third, improving spatial justice and quality of life in deprived neighborhoods increases the value of residents' assets and breaks the local cycle of poverty. To finance these interventions, novel mechanisms such as urban regeneration funds with public-private partnership, renewal bonds based on future project proceeds, and residents' equity participation in mixed residential-commercial schemes can be utilized.

This research also has an important methodological innovation. Integrating quantitative data, weighting indicators, and qualitative evidence enables multi-dimensional and policy-oriented analysis and, specifically, the prioritization of neighborhoods and identification of their internal capacities for infill development interventions. This approach fills a gap in previous studies on integrated planning for informal settlements and provides a localized and scientific model for spatial-social policy-making.

However, there are also limitations to note. First, quantitative data from the first phase (384-person sample) were collected to identify key neighborhoods and initial zoning; they were not designed as a representative survey of the entire city of Mashhad. Therefore, the results of this phase cannot be independently reported as metropolitan-level findings. Second, the research's focus on a specific city (Mashhad) and the use of limited indicators and

criteria for measuring spatial justice and infill development may not cover some dimensions of spatial inequality. Third, generalizing the results to other informal settlements in the country requires complementary studies considering the specific local context of each region.

Suggestions for future research include four main axes:

1. Expanding spatial and temporal scope: Extending the study to other metropolises and integrating long-term data to examine urban policy developments and effects.
2. Developing indicator measurement: Using novel and combined indicators and methods for more comprehensive measurement of spatial justice and infill development feasibility.
3. Employing dynamic and complex modeling methods, particularly using agent-based modeling (ABM) to better understand the nonlinear dynamics of the urban system. This method, by modeling the independent behaviors and interactions of various actors (e.g., residents, developers, local institutions) in a spatial environment, can simulate the long-term consequences of different infill development strategies, land market developments, and participation patterns under conditions of uncertainty and help evaluate policies before implementation.
4. Focus on implementation: From an executive and policy perspective, the proposed interventions are designed directly in response to the three identified structural deficiencies, and the following responsible institutions can take the main charge of guiding and implementing each part. To reduce the spatial gap and the targeted distribution of services, the main responsible institution is Mashhad Municipality in cooperation with the Provincial Government and the Ministry of Roads and Urban Development, with the private sector and local developers assisting implementation through participation in infrastructure projects and investment in urban services. To compensate for the neglect of internal capacities and create incentive mechanisms for renewal, the main responsible institution is the Mashhad Islamic City Council, in cooperation with the National Land and Housing Organization, where the private sector and local developers play key roles in operationalizing the strategy and closing the rent gap through participation in renewal and investment in target fabrics. To strengthen social capital, participation, and establish sustainable local institutions, the General Department of Social Participation of the Provincial Government takes the lead with the support of neighborhood councils and local NGOs, and in this area, the private sector and local developers assist in strengthening the economic sustainability of these institutions by providing advisory services and participating in locally-based entrepreneurial projects. Determining these responsible institutions and stakeholders turns the abstract research findings into practical policy recommendations and, by providing a clear framework for assigning responsibility, inter-sectoral coordination, and resource attraction, significantly increases the article's practical value for decision-makers and implementers.

In summary, the present research shows that achieving sustainable development and spatial justice in Mashhad's informal settlements is only possible through a comprehensive and multi-dimensional approach. This approach directly targets the three deficiencies of the spatial gap, neglect of the inner city, and weak social capital. It considers local participation, strengthening social capital, and smart economic governance alongside infrastructure and land management reform. The presented framework can serve as a localized, practical model for spatial-social planning and pave the way for achieving infill development and a more equitable redistribution of resources and opportunities in the city.

## Authors' Contributions

All authors contributed to the preparation and writing of the article. The share of contribution is as follows:
First author: Study design, data collection and analysis, and drafting of the manuscript (70%). Second author: Review and editing of the scientific content of the article and final review (30%).


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## Conflict of Interest

The authors declared no conflict of interest related to this article.

## EndNotes

[i] In the urban planning and housing literature, there is a subtle distinction between infill development and incremental development or incremental upgrading. Infill development mainly refers to the filling of empty, vacant or underutilized spaces within the built-up area of a city with new construction and is more project-based and physical in scale (Wang et al., 2024). Incremental development, on the other hand, is a process in which residents themselves gradually and step-by-step improve their housing unit or living environment, emphasizing household scale, self-help practices and expansion over time (Bredenoord, 2016). Incremental development is a spontaneous and organic process that may form part of an upgrading project, but is not the same as the broader concept of "upgraded informal settlements", which is an external planned intervention. This article focuses on the first concept (Infill) as a macro-urban planning strategy for the optimal use of inner land, although it considers the role of resident participation (which is prominent in both incremental development and upgrading projects) as a critical facilitating factor in its success

## References


Afsari R., Behzadfar M., & Kheyroddin R. (2021). Explanation of the Formation and Transformation Process of Space Security in informal settlements. *Geographical Urban Planning Research (GUPR)*, 9(1): 231-265. https://doi.org/10.22059/jurbangeo.2021.318349.1452. [In Persian]

Aghajani H., Razzaghian F., & Ghazi R. (2024). Identifying Factors Influencing the Formation and Growth of Informal Settlements in Mashhad (Case Study: Seyedi, Khajeh Rabi, Ghal'e Sakhteman, and Jaddeh Qadim Ghochan Areas). *Geography and Development*, 22(77): 31-54. https://doi.org/ 10.22111/gdij.2024.8681. [In Persian]

Agyabeng, A. N., Peprah, A. A., Mensah, J. K., & Mensah, E. A. (2022). Informal settlement and urban development discourse in the Global South: Evidence from Ghana. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, 76(4), 242-253. https://doi.org/10.1080/00291951.2022.2113428

Ahmed, S., Haklay, M., Tacoli, C., Githiri, G., Dávila, J. D., Allen, A., & Fèvre, E. M. (2019). Participatory mapping and food-centered justice in informal settlements in Nairobi, Kenya. *Geo: Geography and Environment*, 6(1), e00077. https://doi.org/10.1002/geo2.77

Ahvenniemi, H., Pennanen, K., Knuuti, A., Arvola, A., & Viitanen, K. (2018). Impact of infill development on prices of existing apartments in Finnish urban neighborhoods. *International Journal of Strategic Property Management*, 22(3), 157-167. https://doi.org/10.3846/ijspm.2018.1540

Alene, E. T. (2022). Determinant factors for the expansion of informal settlement in Gondar city, Northwest Ethiopia. *Journal of Urban Management*, 11(3), 321-337. doi.org/10.1016/j.jum.2022.04.005

AlHasawi, M., Maatouk, M. M. H., & Qurunfulah, E. (2024). Key success factors of urban infill development: A conceptual framework. *European Journal of Architecture and Urban Planning*, 3(3), 9-17. https://doi.org/10.24018/ejarch.2024.3.3.40

Allahgholitabar F., Piri I., Jafari G. H., Nikpour A., & Hajizadeh M. (2025). Empowerment of Informal Settlements with Emphasis on Good Urban Governance Indicators (Case Study: Babil City). *The Journal of Geographical Research on Desert Areas*, 12(1): 195-214. https://doi.org/10.22034/grd.2025.22151.1635. [In Persian]

Ampofo, J. A., Iddrisu, A., Arfasa, G. F., Mantey, I., & Aniah, E. (2024). Causes of Informal Settlement in Africa: A systematic review. *Adrri journal of contemporary african development*, 1(1 (1), January 2024-March 2024, 1-18. https://journals.adrri.org/en/

Arvin M., & Zanganeh S. (2020). Investigation Barriers Infill Development Approach (Case Study: Ahvaz City). *Sustainable city*, 3(1): 71-87. https://doi.org/10.22034/jsc.2020.196014.1079. [In Persian]

Arzhangi H., Salamati Gabloo S., Mohajeri Naeimi L., Jafar Khani Z., & Khakhjasteh S. (2021). Assessment of Empowerment Strategies of Informal Settlements Based on SWOT-ANP Model (Case Study: Golmoghan Neighborhood of Ardebil). *Geography and Human Relationships*, 3(4): 283-298. Dor: 20.1001.1.26453851.1400.3.4.19.4. [In Persian]

Atkinson, C. L. (2024). Informal settlements: A new understanding for governance and vulnerability study. *Urban Science*, 8(4), 158. https://doi.org/10.3390/urbansci8040158

Azhar, A., Buttrey, H., & Ward, P. M. (2021). "Slumification" of consolidated informal settlements: A largely unseen challenge. *Current Urban Studies*, 9(3), 315-342. https://doi.org/10.4236/cus.2021.93020

Baghban S., & Minaei M. (2023). Spatial Analysis of Social Resilience in Suburbs of Mashhad Based on Multi-Criteria Spatial Decision Support System (MC-SDSS). *Scientific- Research Quarterly of Geographical Data (SEPEHR)*, 32(125): 143-161. https://doi.org/10.22131/sepehr.2023.545658.2834. [In Persian]

Bagheri Miab S., & Karimikia M. S. (2022). Modeling Cultural Policy in the Slums of the City of Ahvaz. *The Journal of Community Development (Rural-Urban)*, 13(2): 561-584. https://doi.org/10.22059/jrd.2022.334052.668694. [In Persian]

Bakhaty, A., Salama, A. M., & Dimitrijević, B. (2023). A validated framework for characterizing informal settlements: Two cases from greater Cairo, Egypt. *Buildings*, 13(5), 1263. https://doi.org//10.3390/buildings13051263

Batty, M. (2009). Cities as complex systems: Scaling, interaction, networks, dynamics, and urban morphologies. In *Encyclopedia of complexity and systems science* (pp. 1041-1071). Springer, New York, NY. https://doi.org/10.1007/978-0-387-30440-3_69

Baye, F., Wegayehu, F., & Mulugeta, S (2020). Drivers of informal settlements in the peri-urban areas of Woldia: Assessment of the demographic and socio-economic trigger factors. *Land Use Policy*, 95, 104573. https://doi.org//10.1016/j.landusepol.2020.104573

Behnisch, M., Krüger, T., & Jaeger, J. A. (2022). Rapid rise in urban sprawl: Global hotspots and trends since 1990. *PLOS Sustain-*

*ability and Transformation*, 1(11), e0000034. https://doi.org/10.1371/journal.pstr.0000034

Beidi Gharaghyeh R., & Arbabi A. (2022). Empowering Informal Settlements by Emphasizing the Social Capital Approach (Case Study: the City of Islamshahr). *Journal of Sustainable Urban & Regional Development Studies (JSURDS)*, 3(3), 1-23. https://www.srds.ir/article_163761.html. [In Persian]

Bettencourt, L. M., & Marchio, N. (2025). Infrastructure deficits and informal settlements in sub-Saharan Africa. *Nature*, 645(8080), 399-406. https://doi.org/10.1038/s41586-025-09465-2

Bibri, S. E., Krogstie, J., & Kärrholm, M. (2020). Compact city planning and development: Emerging practices and strategies for achieving the goals of sustainability. *Developments in the built environment*, 4, 100021. https://doi.org/10.1016/j.dibe.2020.100021

Bin Sulaiman, F. (2023). Compact city: What is the extent of our exploration for its meanings? A systematic review. *Sustainability*, 15(13), 10302. https://doi.org/10.3390/su151310302

Boanada-Fuchs, A., Kuffer, M., & Samper, J. (2024). A global estimate of the size and location of informal settlements. *Urban Science*, 8(1), 18. https://doi.org/10.3390/urbansci8010018

Bredenoord, J. (2016). Sustainable housing and building materials for low-income households. *Journal of Architectural Engineering Technology*, 5(1), 1-9. https://doi.org/10.4172/2168-9717.1000158

Capra-Ribeiro, F. (2024). Spatial Justice: Deductions, Demonstrations, and Derivations. *Anales de Investigación en Arquitectura*, 14(1). https://doi.org/10.18861/ania.2024.14.1.3831

Coleman, J. S. (1988). Social capital in the creation of human capital. *American journal of sociology*, 94, S95-S120. https://doi.org/10.1086/228943

Creswell, J., & Poth, C. (2018). *Qualitative inquiry & research design: Choosing among five approaches* (4th Ed.). Sage Publications. https://pubhtml5.com/enuk/cykh/Creswell_and_Poth%2C_2018%2C_Qualitative_Inquiry_4th/

Dadashpoor, H., & Dehghan, R. (2025). Defining spatial justice: A review. *Habitat International*, 160, 103387. https://doi.org/10.1016/j.habitatint.2025.103387

Dadashpoor H., Alizadeh B., & Rostami F. (2015). Determination of Conceptual Framework from Spatial Justice in Urban Planning with Focus on the Justice Concept in Islamic Schools. *Naqshejahan- Basic studies and New Technologies of Architecture and Planning*, 5(1): 75-84. Dor: 20.1001.1.23224991.1394.5.1.1.2. [In Persian]

Deputy of Planning and Human Capital Development, Mashhad Municipality. (2021). Official Portal. Retrieved from https://planning.mashhad.ir/. [In Persian]

Dovey, K. (2019). Informal settlement as a mode of production. In *the new companion to urban design* (pp. 139-151). Routledge.

Dovey, K., van Oostrum, M., Chatterjee, I., & Shafique, T. (2020). Towards a morphogenesis of informal settlements. *Habitat International*, 104, 102240. https://doi.org/10.1016/j.habitatint.2020.102240

Elkawy, A., & Ahmed, A. (2023). Principles of Infill Development policy towards sustainable urban containment in residential areas. *SVU-International Journal of Engineering Sciences and Applications*, 4(2), 119-148. https://doi.org/ 10.21608/SVUSRC.2023.201444.1117

Eskandari Dorbati Z., Javaheripour M. & Torkaman F. (2022). Land Ownership and Construction of Informal Settlements in Iran (1978-2021). *The Journal of Community Development (Rural-Urban)*, 14(1): 305-331. https://doi.org/10.22059/jrd.2022.345452.668743. [In Persian]

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4. https://doi.org 10.11648/J.AJTAS.20160501.11

Fainstein, S. (2010). *The Just City*. Cornell University Press.

Feitosa, F. O., Wolf, J. H., & Lourenço Marques, J. (2024). Operationalizing spatial justice in urban planning: Bridging theory with practice. *Urban Research & Practice*, 17(5), 720-736. https://doi.org/10.1080/17535069.2024.2341254

Fouad, Z., & Abbas, S. S (2021, April). *The role of urban land management in the informal settlements*. In IOP Conference Series: Earth and Environmental Science (Vol. 754, No. 1, 012014). IOP Publishing. https://doi.org/10.1088/1755-1315/754/1/012014

Galdini, R., & De Nardis, S. (2023). Urban informality and user-led social innovation: Challenges and opportunities for the future human-centered city. *Futures*, 150, 103170. https://doi.org/10.1016/j.futures.2023.103170

Ghazanfarpour H., Karimi S. & Heydari S. (2022). Intermediate Development Planning in Region 3 of Kerman City with a Sustainable Development Approach. *Journal of Urban Social Geography*, 9(1): 253-270. https://doi.org/10.22103/JUSG.2022.2070. [In Persian]

Ghodsi, N., Nastaran, M., & Izadi, A. (2021). Infill development approach: A smart transition way to the sustainable future urban development. *Sustainable Computing: Informatics and Systems*, 32, 100614. https://doi.org/10.1016/j.suscom.2021.100614

Hailu, T., Assefa, E., & Zeleke, T. (2024). Land use transformation by urban informal settlements and ecosystem impact. *Environmental Systems Research*, 13(1), 32. https://doi.org/10.1186/s40068-024-00359-2

Hakimi H., Naghibi H., Asghari Zamani A., & Babaii Aghdm F. (2025). Identifying the Key Factors Affecting the Expansion of Informal Settlements by Structural Analysis Method (Case Study: Shahr Khoy). *Journal of Geography and Planning*, 28(90): 256-230. https://doi.org/10.22034/gp.2024.58401.3186. [In Persian]

Harvey, D. (2008). Revolutionary and counter-revolutionary theory in geography and the problem of ghetto formation. In *Geographic Thought* (pp. 13-22). Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9780203893074-2/revolutionary-counter-revolutionary-theory-geography-problem-ghetto-formation-david-harvey

Hashempour R., Seyfaei M., & Salehi N. (2022). Social Empowerment in Informal Urban Settlements Based on Assets. *Journal of Engineering and Construction Management*, 7(1): 66-74. https://www.jecm.ir/article_156404.html?lang=fa. [In Persian]

Hassan, M. O., Ling, G. H. T., Rusli, N., Mokhtar, S., Wider, W., & Leng, P. C. (2023). Urban sprawl patterns, drivers, and impacts: The case of Mogadishu, Somalia using geo-spatial and

SEM analyses. *Land*, 12(4), 783. https://doi.org/10.3390/land12040783

He, Q., Zeng, C., Xie, P., Tan, S., & Wu, J. (2019). Comparison of urban growth patterns and changes between three urban agglomerations in China and three metropolises in the USA from 1995 to 2015. *Sustainable Cities and Society*, 50, 101649. https://doi.org/10.1016/j.scs.2019.101649

He, S. Y. (2020). Regional impact of rail network accessibility on residential property price: Modelling spatial heterogeneous capitalization effects in Hong Kong. *Transportation Research Part A: Policy and Practice*, 135, 244-263. https://doi.org/10.1016/j.tra.2020.01.025

Hossain, M. S. (2021). Exploring the architectural dimensions of vulnerability: A case of the participatory upgradation in informal settlement at Talaimari, Rajshahi. *Journal of Engineering Science*, 12(2), 29-46. https://doi.org/10.3329/jes.v12i2.54629

Iran Urban Regeneration Company. (2025). Report on Informal Settlements of Mashhad Metropolis. [In Persian]

Iranmanesh, A., & Kamalipour, H. (2025). Towards a configurational typology of informal settlements: A syntactic analysis of informal settlements in Nagpur. *Journal of Urban Affairs*, 1-21. https://doi.org/10.1080/07352166.2025.2455611

Jamini D., Jamshidi A., & Abdolmaleki M. (2022). Identifying the Challenges of Informal Settlements and Providing Operational-Executive Solutions to Improve Them in Kurdistan Province (Case Study: Urban Separated Area of Naysar). *Research and Urban Planning*, 12(47): 111-130. https://doi.org/10.30495/jupm.2021.27932.3875. [In Persian]

Jones, R., & Moisio, S. (2025). Regions and the search for spatial justice: a question of capacity? *Regional Studies*, 59(1), 2390505. https://doi.org/10.1080/00343404.2024.2390505

Jun, H. J., Kim, D., Kim, J. H., & Heo, J. P. (2024). Detection of infill development and contributing factors using deep learning and multilevel modeling. *Cities*, 150, 105019. https://doi.org/10.1016/j.cities.2024.105019

Kamalipour, H. (2023). Shaping public space in informal settlements: A case study. *Sustainability*, 15(4), 3781. https://doi.org//10.3390/su15043781

Karami Shaban Abadi D., & Qanbari P. (2021). Intermediate Development with the Approach of Smart Urban Growth (the Central and Dilapidated Fabric of Kermanshah City). *Geography (Regional Planning)*, 11(45): 1031-1051. https://doi.org/10.22034/jgeoq.2021.198464. [In Persian]

Kheiroddin R., & Salahimoghadam A. (2021). The Empowerment of Informal Settlements by Moving from the Need-Based to Asset-Based Approach (Case Study of Farahzad, One of the Tehran's Neighborhoods). *Quarterly Journals of Urban and Regional Development Planning*, 6(17): 29-58. https://doi.org/ 10.22054/urdp.2021.59544.1304. [In Persian]

Khosh Sima, M., Asgharei Zamani A., & rostaei S. (2020). Study of the Role of Infill Development in Renovation of Urban Old Textures (Case Study: Hokm Abad Region of Tabriz). *Journal of Geography and Planning*, 24(72): 183-204. https://doi.org/10.22034/gp.2020.10834. [In Persian]

Lees, L., Slater, T., & Wyly, E. K. (Eds.). (2023). *The planetary gentrification reader*. New York, NY, USA: Routledge. https://doi.org/10.4324/9781003341239

Li, X., Zhou, Y., Hejazi, M., Wise, M., Vernon, C., Iyer, G., & Chen, W. (2021). Global urban growth between 1870 and 2100 from integrated high resolution mapped data and urban dynamic modeling. *Communications Earth & Environment*, 2(1), 201. https://doi.org/10.1038/s43247-021-00273-w

Mahabadipoor M. M., Zanganeh A. & Talkhabi H. R. (2025). Assessing the Capacity and Ranking Regions of Varamin City with Infill Development Approach. *Sustainable Development of Geographical Environment*, 6(11): 1-20. https://doi.org/10.48308/sdge.2025.237840.1224. [In Persian]

Marnane, K., & Greenop, K. (2023). Housing adequacy in an informal built environment: case studies from Ahmedabad. *Journal of Housing and the Built Environment*, 38(3), 2059-2082. https://doi.org/10.1007/s10901-023-10029-x

Marutlulle, N. (2017). Causes of informal settlements in Ekurhuleni Metropolitan Municipality: An exploration. *Africa's Public Service Delivery and Performance Review*, 5(1), 1-11. https://journals.co.za/doi/abs/10.4102/apsdpr.v5i1.131

Miranda, T. I., Listiani, N., Purwono, N., Kusumaningrum, D., Yossa, N., & Suhodo, D. S. (2025). Informality and social innovation: the survival strategy of neglected communities in Jakarta's East Flood Canal. *Journal of Urban Management*. https://doi.org/10.1016/j.jum.2025.09.008

Moghadam, A., & Maleki, S. (2025). Feasibility Study of Urban Interstitial Development (Case Study: Abadan City). *Geography and Human Relationships*, e226123. https://doi.org/10.22034/gahr.2025.535332.2538. [In Persian]

Mohammadi-Hamidi, S., Beygi Heidarlou, H., Fürst, C., & Nazmfar, H. (2022). Urban infill development: a strategy for saving peri-urban areas in developing countries (the case study of Ardabil, Iran). *Land*, 11(4), 454. https://doi.org/10.3390/land11040454

Moretti, J. A., Cavalcanti, E. R., Brasil, A. B., & Moretti, R. D. S. (2024). Occupation of vacant buildings in central districts by social movements as a means to deal with climate change in an inclusive way: the cases of cities São Paulo and Natal. *Environment & Urbanization*, 36(1), 33-52. https://doi.org/10.1177/09562478241230814

Moroni, S., & De Franco, A. (2024). Spatial justice: A fundamental or derivative notion? *City, Culture, and Society*, 38, 100593. https://doi.org/10.1016/j.ccs.2024.100593

Nasehi S., Nohegar A., & Farhadi R. (2023). Spatiotemporal Analysis of Urban Growth Patterns to Provide Strategies for Sustainable Land Planning (Case Study: Bandar Abbas City). *Geography and Environmental Sustainability*, 13(4): 69-83. https://doi.org/10.22126/ges.2023.9381.2675. [In Persian]

Nowin D., Taghavi E., & Ezzatpanah B. (2022). Empowerment of Informal Settlements with Emphasis on Desirable Urban Governance Indicators (Case Study: Informal Settlements of Tabriz Metropolis). *Spatial Planning*, 12(3): 109-122. https://doi.org/10.22108/sppl.2023.135434.1673. [In Persian]

Oraiopoulos, A., Wieser, M., Verdiere, M., Lambert, R., Fennell, P., & Ruyssevel, P. (2025). Improving habitability in informal settlements in the Global South: Exploring the impact of community urban green infrastructure on outdoor heat stress. *Building and Environment*, 113787. https://doi.org/10.1016/j.buildenv.2025.113787

Ouma, S., Cocco Beltrame, D., Mitlin, D., & Beth Chitekwe-Biti, B. (2024). Informal settlements: Domain report. ACRC Working

Paper 2024-09. Manchester: African Cities Research Consortium, the University of Manchester. http://dx.doi.org/10.2139/ssrn.4765001

Pakzad E., Shahivandi A., & Irandoost K. (2023).Selecting a New Pattern for the Betterment of Informal Settlements in Iran. *Mmi*, 13. (35): 5. http://mmi.aui.ac.ir/article-1-1401-fa.html. [In Persian]

Parizadi T., mirzazadeh H., Asghary R., & karimi A. (2022). The Study of Physical Development Pattern with the Approach of Infill Development Case Study: Miandoab City. *Human Geography Research*, 54(4): 1303-1321. https://doi.org/10.22059/jhgr.2021.323421.1008298. [In Persian]

Portugali, J. (2024). Complexity, coordination dynamics, and the urban landscape. *Buildings*, 14(5), 1327. https://doi.org/10.3390/buildings14051327

Pourahmad A., Hataminejad H., & Charkhan S. (2021). Analysis of Spatial Inequality of Formal and Informal Settlements in Neighborhoods of Tehran's District Two. *Journal of Geography and Regional Development*, 19(1): 322-295. https://doi.org/10.22067/jgrd.2021.69240.1023. [In Persian]

Putnam, R. D. (2015). Bowling alone: America's declining social capital. In *The City Reader* (pp. 188-196). Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315748504-30/bowling-alone-america-declining-social-capital-robert-putnam

Rezaee S., Aryan A., & Mohammadpour S. (2025). An Analysis of the Distribution of Urban Services with an Emphasis on the Spatial Justice Approach (Case Study: Mashhad City). *Urban Economics and Planning*, 6(1): 96-117. https://doi.org/10.22034/uep.2025.499567.1586. [In Persian]

Rezaei S., Karimian Bostani M., & Miri G. (2023). Identifying the drivers Affecting Urban Regeneration of informal Settlements Using Futures Studies Approach (Case Study: Zahedan City). *Geography and Urban Space Development*, 9(4): 127-149. https://doi.org/10.22067/jgusd.2022.70702.1053. [In Persian]

Rigon, A. (2022). Diversity, justice, and slum upgrading: An intersectional approach to urban development. *Habitat International*, 130, 102691. https://doi.org/10.1016/j.habitatint.2022.102691

Rizkiya, P., Haikal, N., Hasan, Z., Aulia, F., Gunawan, A., & Fuady, Z. (2023, December). The Urban Sprawl Typology and the Urban Growth Pattern of the Peri-Urban Area in Aceh Besar Regency, Aceh. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1276, No. 1, p. 012041). IOP Publishing. https://doi.org/10.1088/1755-1315/1276/1/012041

Rybski, D., & González, M. C. (2022). Cities as complex systems—Collection overview. *Plos one*, 17(2), e0262964. https://doi.org//10.1371/journal.pone.0262964

Saberi A., Pourahmad A., & Zanganeh Shahraki, S. (2024). Analyzing the Distribution of Urban Services and Identifying Drivers Affecting Spatial Justice with a Future Study Approach (Case Study: Yasouj City). *Journal of Geography and Planning*, 28(88): 191-164. https://doi.org/10.22034/gp.2023.54478.3068. [In Persian]

Saeedi Mofrad S., Hanaei T., & Shirvani Moghaddam S. (2021). Presenting Effective Solutions for the Promotion of Spatial Justice in Informal Settlements of Mashhad Metropolis. *Journal of Studies of Human Settlements Planning (Geographical Landscape)*, 16(3): 551-566. https://dor.org/20.1001.1.25385968.1400.16.3.11.8. [In Persian]

Saeedi Monfared S., Hanaee T., & Shirvani Moghadam S. (2020). Explaining the Physical and Functional Components Affecting the Spatial Justice in the Marginal Settlements of Mashhad Metropolis. *Journal of Sustainable Architecture and Urban Design*, 8(1): 67-81. https://doi.org/ 10.22061/jsaud.2020.4956.1437. [In Persian]

Samper, J., Shelby, J. A., & Behary, D. (2020). The paradox of informal settlements revealed in an ATLAS of informality: Findings from mapping growth in the most common yet unmapped forms of urbanization. *Sustainability*, 12(22), 9510. https://doi.org/10.3390/su12229510

Schwab, E. (2018). *Spatial justice and informal settlements: Integral urban projects in the Comunas of Medellín*. Emerald Publishing Limited. https://doi.org/10.1108/9781787147676

Setianto, M. A. S., & Gamal, A. (2021, February). Spatial justice in the distribution of public services. In *IOP Conference Series: Earth and Environmental Science* (Vol. 673, No. 1, p. 012024). IOP Publishing. https://doi.org/10.1088/1755-1315/673/1/012024

Shand, W., & Ndezi, T. (2025). Community-Led climate adaptation in informal settlements. World Bank. Washington DC. https://hdl.handle.net/10986/43146

Shao, Z., Sumari, N. S., Portnov, A., Ujoh, F., Musakwa, W., & Mandela, P. J. (2021). Urban sprawl and its impact on sustainable urban development: A combination of remote sensing and social media data. *Geo-Spatial Information Science*, 24(2), 241-255. https://doi.org/10.1080/10095020.2020.1787800

Sharif Zadegan M. H., & Safavi S. F. (2023). Institutional Solutions for Dealing with Informal Settlements in the Country with an Emphasis on Justice (Case Study: Tehran Metropolis). *Spatial Planning and Development Policy Journal*, 1(1). https://doi.org/10.48308/spdp.2023.103702. [In Persian]

Shojaeian A., Nikpour A., Aligholizadeh Firouz Jaei N., & Soleymani M. (2023). Identifying Potential Areas for Infill Development Using Remote Sensing: Ahvaz Metropolis. *Motaleate Shahri*, 12(45): 83-96. https://doi.org/10.34785/J011.2023.009. [In Persian]

Slater, T. (2006). The eviction of critical perspectives from gentrification research. *International journal of urban and regional research*, 30(4), 737-757. https://doi.org/10.1111/j.1468-2427.2006.00689.x

Smith, N. (1987). Gentrification and the Rent Gap. *Annals of the Association of American Geographers*, 77(3), 462–465. https://doi.org/10.1111/j.1467-8306.1987.tb00171.x

Soja, E. (2010). Spatializing the urban, Part I. *City*, 14(6), 629-635. https://www.tandfonline.com/doi/full/10.1080/13604813.2010.539371

Soja, E. W. (2010). *Seeking Spatial Justice*. University of Minnesota Press.

Statistical Center of Iran. (2025). *Population and Housing Census*. Retrieved from https://amar.org.ir/population-and-housing-census#app3146. [In Persian]

Taherian, H. (2024). Analysis of Spatial (Socio-Economic) Inequality in Informal Settlements with the Aim of Promoting Spatial Justice (Case Study: District 18 of Tehran). *Journal of Urban*

*Economics and Management*, 12(46): 141-157. http://iueam.ir/article-۱-۲۱۰۷-fa.html. [In Persian]

Teymouri M. (2024). Marginalization in the City of Mashhad: A Meta-analysis of Existing Research. (e197515). *Journal of National Social Capital Research*, 2(1): e197515. https://www.jisr.ir/article_197515.html. [In Persian]

Triandafyllidou, A., Moghadam, A., Kelly, M., & Şahin-Mencütek, Z. (2024). Migration and cities: An introduction. In *Migration and Cities: Conceptual and Policy Advances* (pp. 1-18). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-55680-7_1

Tzanni, O., Nikolaou, P., Giannakopoulou, S., Arvanitis, A., & Basbas, S. (2022). Social dimensions of spatial justice in the use of the public transport system in Thessaloniki, Greece. *Land*, 11(11), 2032. https://doi.org/10.3390/land11112032

UN-Habitat (2022). Global action plan (GAP) Launch: Accelerating for transforming informal settlements and slums by 2030. www.unhab itat.orgwww.mypsup.org

Habitat, U. N. (2020). *World cities report: The value of sustainable urbanization. United Nations Human Settlements Programme (UN-Habitat)*. https://unhabitat.org/sites/default/files/2020/10/wcr_2020_report.pdf. (Accessed 26 December 2023) 2023.

UN-Habitat. (2022). *World cities report 2022: Envisaging the future of cities. United Nations Human Settlements Programme (UN-Habitat)*. https://unhabitat.org/world-cities-report-2022-envisaging-the-future-of-cities

UN-Habitat. (2025). *From housing informality to adequate housing: Background paper and draft recommendations. United Nations Human Settlements Programme*. https://unhabitat.org/sites/default/files/2025/06/informal_settlements_-_background_paper_and_draft_recommendations.pdf

Wang, X., Xiong, L., & Wang, Z. (2024). Simplified Model Study of Autoclaved Aerated Concrete Masonry Flexible Connection Infilled Frames with Basalt Fiber Grating Strips. *Buildings*, 14(4), 1033. https://doi.org/10.3390/buildings14041033

World Bank. (2022). Informal settlements in Romania: Situational analysis. https://documents1.worldbank.org/curated/en/099062123013526907/pdf/P1761690122ece-050b24e0994a1005f38c.pdf

Xin, S., & Guo, Q. (2025). Beyond distribution: Critique of Spatial justice theories (case study of Shanghai's 15-Minute City). *Land*, 14(1), 189. https://doi.org/10.3390/land14010189

Ye, Y., & Yang, Y. (2023). A review of research on urban playability from a social justice perspective. Land, 12(5), 1027. https://doi.org/10.3390/land12051027

Yousefi Azarabarghani S., Majedi H., & Saeideh Zarabadi Z. S. (2022). Analysis of Scattered Supernatant Patterns in Tehran Urban Complex Emphasizing on the Approaches of the Urban Management System. *JGS*. 22(65): 439-459. https://doi.org/10.52547/jgs.22.65.439. [In Persian]

Zebardast E., & Ghanooni H. (2021). Analysis of Urban Sprawl Effects on Social Vulnerability (Case Study: Qazvin City Districts). *Journal of Urban Sustainable Development*, 2(4): 15-34. dor: 20.1001.1.27170128.1400.2.4.2.9. [In Persian]

Zhang, L., Shu, X., & Zhang, L. (2023). Urban sprawl and its multi-dimensional and multiscale measurement. *Land*, 12(3), 630. https://doi.org/10.3390/land12030630