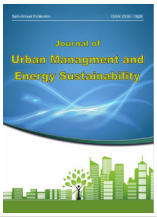
Int. J. Urban Manage. Energy Sustainability, 6(4): 161-180, 2025

International Journal of Urban Management and Energy Sustainability (IJUMES)

Homepage: http://www.ijumes.com



ORGINAL RESEARCH PAPER

Typological Analysis of Informal Settlements for Developing Climate-Responsive Architectural Indicators: An Integrated Fuzzy Delphi–FAHP Approach

Aliaskar Jamshidi Zardak[1], Mohammad Parva[*1], Khosro Movahed[1]

1 *Department of Architecture, Shi.C., Islamic Azad University, Shiraz, Iran*

ARTICLE INFO

Article History:
Received 2025-11-28
Revised 2026-01-23
Accepted 2026-02-26

Keywords:
Architectural indicators, Fuzzy Delphi–FAHP, informal settlements, spatial legibility, typological analysis

ABSTRACT

Rapid urbanization and the expansion of informal settlements have intensified the need for analytical frameworks that move beyond descriptive approaches toward operational architectural evaluation. This study aims to formulate and prioritize architectural indicators for informal settlements through an analytical typological approach that integrates expert consensus with multi-criteria decision-making. The research adopts a mixed-methods analytical design grounded in a pragmatic paradigm, combining theoretical review with empirical evaluation. Initially, key architectural dimensions, Form, Space, Materials, and Spatial Organization, were extracted through literature-based typological analysis. Primary data were then collected from a purposively selected panel of architects, urban planners, and academic specialists using structured Likert-scale questionnaires. A four-round Fuzzy Delphi process was applied to refine and validate influential factors, followed by the Fuzzy Analytic Hierarchy Process to determine the relative weight of final indicators. The findings demonstrate a progressive convergence of expert consensus, resulting in five prioritized indicators: Physical Stability, Spatial Legibility, Physical Safety, Social Interaction, and Functional Accessibility. Among these, Physical Stability achieved the highest weight, highlighting its foundational role in improving informal settlement environments, while socio-spatial factors such as Social Interaction emphasized the importance of human-centered design. The integrated Delphi–FAHP framework reveals that architectural upgrading strategies in informal contexts require a balanced synthesis of structural resilience, spatial clarity, safety, and accessibility rather than isolated technical interventions. Overall, the study contributes a structured and climate-responsive analytical model that bridges typological understanding with quantitative prioritization, offering practical guidance for architects, planners, and policymakers engaged in the sustainable transformation of informal settlements.

DOI: 10.22034/ijumes.2026.2079165.1350

Running Title: Physical Informal Settlements for Developing Climate-Responsive Architectural Indicators

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
36	07	12

*Corresponding Author:
Email: *Mo.parva@iau.ac.ir*
Phone: +989171130447
ORCID: https://orcid.org/0000-0002-1272-0684

INTRODUCTION

Rapid urban population growth, along with environmental and economic pressures, has led informal settlements to emerge as immediate and strategic responses to residents' housing needs in the face of investment constraints and limited urban land availability. However, these settlements are often confronted with a lack of sustainable design approaches, inadequate architectural supervision, and the absence of mechanisms for implementing construction standards, resulting in increased physical and social insecurity (UN-Habitat, 2020).

In this context, the absence of Physical Stability in informal settlements characterized by a combination of diverse land uses, non-linear urban fabrics, and imbalanced densities necessitates a multi-vector analytical approach for the typological classification of their functional structures and the development of Architectural Indicators. Such an approach enables a composite analysis aligned with local realities (Duarte & Silva, 2018). Analytical approaches to the typology of informal settlements must also be integrated with local data, cultural sensitivities, and emerging technologies such as spatial analysis and dynamic modeling in order to derive meaningful and operationalizable indicators, thereby contributing to forward-looking design and implementation decisions (Pakdel et al., 2025, Estifaei et al.,2025). Despite the diversity of urban contexts, the objective of this architectural–urban approach in formulating Architectural Indicators is to transcend mere description of the existing condition, enhance spatial performance and quality of life, and ultimately evolve into an operational framework for planners and policymakers (Lee & Park, 2022). To achieve this objective, international experiences demonstrate that architectural indicator-based models, when adapted to local characteristics, can improve executive decision-making in the redesign of informal residential environments and, through functional evaluation frameworks, articulate socio-biological sustainability (Garcia et al., 2021). Within this framework, emerging technologies such as GIS, three-dimensional modeling, and big data analytics possess significant potential for extracting Architectural Indicators from informal settlements. When combined with local community participation, these tools can provide a reliable roadmap for improving living conditions (Ramos & Silva, 2020).

Moreover, analytically driven approaches must be accompanied by a deep understanding of social transformations and residents' behavioral patterns in order to generate indicators that not only reflect current conditions but also possess the capacity to anticipate and respond to socio-economic fluctuations (Fowler, 2018). Major challenges in this field primarily relate to the lack of accurate data, the absence of clear standards for evaluating spatial performance, and the deficiency of architectural value criteria associated with spatial justice and urban functions. These limitations can significantly influence decision-making processes and constrain the development of indicators (Afshoun et al., 2025). Therefore, establishing an analytical approach to the typology of informal settlements should be designed through the integration of qualitative and quantitative methods, field data, and participatory mechanisms to achieve a deeper understanding of construction processes, land use patterns, and social transformations ultimately translating this understanding into implementable executive strategies (Fowler, 2018). Access to reliable resources and data, alongside the application of integrated qualitative–quantitative analytical approaches, can lead to a more precise understanding of the production processes of informal settlements and serve as a foundation for developing Architectural Indicators within functional evaluation frameworks. This perspective, particularly in developing countries and regions characterized by uneven urban investment, can enhance executive decision-making in the redesign of informal residential spaces and improve urban landscapes through socio-biological sustainability

models (Garcia et al., 2021). Additionally, the integration of field data with emerging technologies such as GIS and big data analytics provides opportunities for precise mapping of informal settlement fabrics, thereby strengthening evidence-based architectural approaches (Ramos & Silva, 2020). In addressing the rapid growth of deteriorated and informal urban settlements, governments have adopted diverse perspectives and policies, ranging from the most pessimistic approaches typically involving coercive measures and demolition to reform-oriented (conciliatory) interventions. Apart from coercive responses, which are now definitively regarded as unacceptable due to their adverse impacts on other dimensions of urban life, intervention strategies may be categorized according to the lever of intervention, the pattern of intervention (direct or indirect), and temporal phases (Rafian, 2008). Multi-criteria evaluations concerning access to urban services, security of public spaces, and spatial land uses are presented as reflections of urban design and neighborhood-level policymaking; these reflections contribute to the conceptual redefinition of informal settlements. Accordingly, simultaneous analysis of these dimensions enables a more precise understanding of settlement conditions. Within the framework of people-centered design theories, social participation not only enhances the legitimacy of design but can also foster cultural and neighborhood identity adaptations aligned with rapid urban transformation processes and diverse pressures, ultimately generating empathetic dialogue among residents. The application of network-based and spatio-temporal analyses as analytical tools enables a comprehensive understanding of spatial distribution, mobility flows, and social interactions, thereby contributing to the formulation of Architectural Indicators through more precise qualitative and quantitative methodologies. The objective of this research is the typological classification of informal settlements for the formulation of Architectural Indicators, as well as the analysis and evaluation of typological components of informal housing, with the aim of contributing to the enhancement of informal settlements.

MATERIALS AND METHODS

The Concept of Informal Settlements

Spatial disparities within urban structures, severe deprivation among social groups, and ultimately the transformation of rural poverty into urban poverty have led to the emergence of informal settlements within or adjacent to cities—particularly large metropolitan areas—in a spontaneous manner, lacking building permits and urban planning frameworks, and characterized by concentrations of low-income populations and low levels of quantitative and qualitative living standards (Sarrafi, 2002). These settlements have been described by terms such as marginal settlements, informal housing, spontaneous settlements, and deteriorated settlements. Given the inadequacy of terms such as marginalization and slum dwelling in encompassing all forms of this phenomenon, the term informal settlement is employed in a broader sense to replace marginalization and slum dwelling. Accordingly, the concept of informal settlement includes marginal settlements and their multiple manifestations (Davoudpour, 2005). Informal settlements refer to forms of human habitation that have emerged outside the formal frameworks of urban planning, legal land tenure systems, and statutory construction regulations. According to the definition provided by the United Nations Human Settlements Programme, these settlements are typically characterized by insecure land tenure, lack of full access to basic urban services, low physical quality, and non-compliance with formal regulations (UN-Habitat, 2003). In this definition, informality is understood not merely as a physical attribute, but as a legal, institutional, and social condition. Within critical theoretical literature, informal settlements are analyzed as a direct consequence of structural inequalities in the production of space. Castells conceptualizes these settlements as the outcome of con-

tradictions between the capital-driven logic of the city and the livelihood needs of low-income groups, emphasizing that informality constitutes an inseparable component of contemporary capitalist urbanism (Castells, 1977). From this perspective, informal settlements are not exceptions but integral elements of unequal urbanization. More human-centered approaches, such as Turner's perspective, interpret informal settlements as rational responses to the inefficiencies of formal housing systems. Within this framework, housing quality depends less on formal standards and more on the degree of control and participation of residents in the housing production process, and informal settlements are regarded as dynamic and upgradable spaces (Turner, 1976). Informal settlements, as one of the most significant spatial manifestations of the contemporary city, reflect structural gaps within economic, social, and urban planning systems that have expanded globally, particularly in developing cities. These settlements are not solely products of urban poverty but are the result of complex interactions among institutional forces, land and housing policies, intra-regional migration, and the inability of formal urban structures to respond to the housing needs of low-income groups (UN-Habitat, 2003; Davis, 2006). In theoretical literature, informal settlements have often been described through concepts such as marginalization, spontaneous settlement, and illegal land occupation; however, recent critical research emphasizes that such simplified definitions overlook the internal complexities of these spaces (Roy, 2005). Informal settlements are human settlements that do not comply with legal requirements and are constructed without formal processes of legal land tenure, property transfer, construction regulations, and urban planning procedures (Declaration, 2004). From an architectural and urban perspective, these settlements possess spatial logic and analyzable physical patterns, which in many cases demonstrate greater flexibility and responsiveness than the formal city. One of the fundamental challenges in the study of informal settlements is the tendency to treat them as homogeneous phenomena. This homogenizing view has resulted in intervention policies designed without understanding their internal, contextual, and physical differences, leading to repeated failures (Huchzermeyer, 2009).In practice, informal settlements are recognized as multidimensional phenomena within the urban fabric, consistently shaped by historical, economic, and urban policy interactions. They cannot be regarded merely as outcomes of disorder or budgetary shortages. Rather, they function as dynamic socio-spatial systems reproduced through changes in resources, housing demand, and local investment patterns, reinforced by informal market mechanisms and neighborhood exchange networks (Vitriana et al., 2026). The physical–spatial structure refers to the organization of physical elements in space and the relationships among them, including building layout patterns, street networks, open spaces, and their interrelations (Hillier & Hanson, 1984).

Typology of Informal Settlements

The typology of informal settlements represents one of the most significant analytical tools for understanding the diversity, complexity, and dynamism of this phenomenon on a global scale. Contrary to common assumptions, informal settlements are not uniform or homogeneous; rather, they assume diverse forms across different economic, social, physical, and institutional contexts (UN-Habitat, 2003). Typology, as an analytical tool, refers to the process of identifying, classifying, and analyzing phenomena based on their shared and distinctive characteristics. In urban and architectural studies, typology facilitates the understanding of spatial and residential diversity and moves beyond purely descriptive approaches (Moudon, 1997). In relation to informal settlements, typology distinguishes among various forms of informality based on criteria such as mode of formation, degree of Physical Stability, re-

lationship with the formal city, and level of institutional intervention (Payne, 2005). This differentiation provides a foundation for more precise analysis and the formulation of context-sensitive intervention strategies. One of the most common types is squatter settlements or land occupation, in which residents occupy public or private land without formal ownership. This type frequently emerges during early phases of accelerated urbanization (Turner, 1976). Such settlements typically begin with temporary structures, unstable materials, and lack of basic infrastructure, but over time and with population stabilization, they gradually transform into semi-permanent settlements (Perlman, 2010). The second type comprises incremental self-built settlements, in which households develop housing units progressively in accordance with their economic capacity. This pattern is particularly prevalent in Latin America and Asia (Abrams, 1964). In these settlements, physical quality improves gradually, and local social structures take shape. Although they remain informal, they tend to be more stable than temporary settlements. Another type includes informal settlements associated with the informal economy. These settlements typically emerge adjacent to industrial centers, markets, or transportation corridors (Castells & Portes, 1989). In this type, proximity to employment opportunities is prioritized over environmental quality and Physical Safety, and settlements are often developed on hazardous or unsuitable land. A fourth type consists of informal settlements resulting from forced migration. Wars, natural disasters, and political crises drive populations toward cities, where they are compelled to settle informally (UNHCR, 2019). Although these settlements often originate as emergency accommodations, many evolve into permanent settlements that remain outside formal planning cycles. Another category includes inner-city informal settlements, which emerge within deteriorated urban fabrics, abandoned spaces, or vacant buildings. This pattern is more common in large and dense cities (Azhar, Buttrey, & Ward, 2021). In such cases, informality occurs within the core of the formal city and often involves illegal occupation or unauthorized change of use. The sixth type comprises peripheral informal settlements that develop along the spatial edges of cities, beyond the coverage of formal services. This represents the most common pattern of marginal settlement in developing countries (UN-Habitat, 2010). These settlements generally lack adequate access to transportation networks, urban services, and public spaces, and exhibit strong dependence on the central city. Some studies classify informal settlements based on the degree of government intervention. Within this framework, abandoned settlements, upgrading settlements, and integrated settlements are distinguished from one another (Payne, 2005). Abandoned settlements typically lack any institutional support and persist under minimal living conditions, whereas upgraded settlements have benefited from gradual interventions. Another type consists of ethnic–cultural informal settlements formed through kinship and identity networks. This pattern is often observed among ethnic or international migrants (Roy, 2005). In such settlements, strong social cohesion can partially compensate for physical and institutional deficiencies, although the risk of social exclusion remains. In certain cities, informal settlements emerge directly from urban renewal projects and population displacement processes. These settlements often develop in newly established and unplanned locations (Smith, 1994). From a physical perspective, typology may also be conducted based on construction materials, density, street patterns, and settlement morphology. This approach is particularly significant for extracting Architectural Indicators. Some settlements exhibit organic and compact patterns, while others develop in dispersed and low-density forms. These differences directly influence the quality of life and interven-

tion potential. Overall, the typology of informal settlements demonstrates that this phenomenon cannot be analyzed or managed through a single, uniform approach. Each type possesses its own internal logic, needs, and capacities. Accurate recognition of typologies constitutes a prerequisite for formulating Architectural Indicators and urban indicators aligned with the realities of informal settlements. Case studies, including those in Iranian cities, reveal the simultaneous presence of multiple types, requiring a flexible and analytical framework for comprehensive evaluation. Ultimately, the typology of informal settlements serves as a tool for transitioning from a generalized perspective toward a precise, context-specific, and intervention-oriented understanding of this complex phenomenon. (Tab.1)

Table 1: Typology of Informal Settlements and Their Characteristics (Source: Authors)

Type of Informal Settlement	Formation Process	Physical Characteristics	Socio–Economic Characteristics
Squatter Settlement	Illegal land occupation	Temporary construction, high density	Severe poverty, insecure land tenure
Gradual Self-Built Settlement	Phased construction by residents	Gradual quality improvement	Relative population stability
Informal Economy-Dependent Settlement	Proximity to employment centers	Settlement on hazardous land	Predominantly informal employment
Forced Migration Settlement	War and crisis	Emergency construction	High vulnerability
Intra-Urban Informal Settlement	Occupation of abandoned spaces	High density, deterioration	Social
Peri-Urban Settlement	Development outside city boundaries	Lack of infrastructure	Dependence on central city
Ethnic–Cultural Settlement	Kinship networks	Spatial cohesion	High social solidarity
Reproduced Settlement	Displacement due to urban renewal	Inappropriate site selection	Residential instability

Architectural Indicators in Informal Settlements

Architectural Indicators refer to a set of identifiable characteristics and elements within the built environment that express the logic of formation, spatial organization, and physical quality of space. These indicators may include building form, materials, density, street patterns, spatial scale, and the configuration of physical elements (Rapoport, 2005). In informal settlements, Architectural Indicators are often the result of residents' spontaneous actions in response to economic, legal, and environmental constraints. These indicators reflect ways of living, local culture, and adaptive strategies to unstable conditions (Turner, 1976).

Form

Form in informal settlements reflects a self-built and incremental development process under conditions of limited resources. These forms are generally shaped by functional necessity, land constraints, and topography, and they evolve organically in both vertical and horizontal dimensions. The geometry of residential units is typically simple and expandable, enabling phased extensions and increased density within small plots. Plans are flexible and allow for changes in use, as well as vertical or horizontal expansion. The pattern of building placement is often adapted to land conditions and access routes, with higher density in central areas and more

dispersed configurations toward the periphery. Formal elements such as volume, height, and orientation are primarily influenced by daylight, ventilation, and climatic conditions, and roofs are designed to be simple and extendable. Despite geometric simplicity and repetitive configurations, these forms reflect the cultural and local identity of residents and establish a balance between overall cohesion and the diversity of self-built details. Overall, the form of informal settlements expresses a synthesis of necessity, environmental adaptation, and pragmatic creativity in the production of residential space. (Tab.2)

Table 2: Form Indicator and Related Indicators within the Category of Form in Informal Settlements and Their Characteristics (Source: Authors)

Indicator	Key Concept	Characteristics	Research Example/ Reference	Architectural Implications
Form	Self-built and gradual	Simple massing, flexible plan, phased development	Turner, 1976	Possibility of unit addition, response to land constraints, organic growth
Density	Variable, nested	Higher central density, scattered periphery	Roy, 2005	Pattern of dispersion and spatial cohesion, flexibility in network design
Orientation & Climate	Environmentally adaptive	Use of light, wind, and solar radiation	Norberg-Schulz, 1980	Climate-appropriate form, reduced energy consumption, bioclimatic comfort
Cultural Identity	Reflection of residents' identity	Indigenous and traditional elements	Oliver, 2006	Context-sensitive architecture, transmission of local culture and identity
Flexibility	Horizontal and vertical development	Internal functional changes, gradual expansion	Turner, 1976; Hamdi, 2010	Growth and adaptability, response to economic and household needs

Space

Space in informal settlements emerges from residents' self-organization in response to constraints of land and resources, developing organically and incrementally over time. Spatial organization directly responds to the social and functional needs of households, and interior spaces are typically multifunctional, compact, and adaptable in order to accommodate economic conditions and household transformations. The spatial network among housing units and passageways is complex and non-linear, shaped by topography, movement patterns, and land limitations. Density tends to be higher within central cores and more dispersed along peripheral areas. Public and semi-public spaces such as pathways, courtyards, and local gathering points emerge gradually and play a significant role in fostering Social Interaction, strengthening social capital, and cultivating a sense of belonging. Within these settlements, private and public spaces are intertwined, establishing a balance between privacy and social engagement. Spatial development is often incremental and phased, and despite geometric asymmetry, the overall spatial organization maintains neighborhood cohesion. In sum, the spatial pattern of informal settlements reflects environmental adaptation, localized social relations, and indigenous innovation in the production of flexible and dynamic spatial environments. (Tab.3)

Table 3: Space Indicator and Related Indicators within the Category of Space in Informal Settlements and Their Characteristics (Source: Authors)

Indicator	Key Concept	Characteristics	Research Example / Reference	Architectural Implications
Space	Multifunctional and Flexible	Adaptable floor plan, incremental extension	Turner, 1976; Payne, 2005	Response to changing household needs, possibility of gradual development
Collective Spaces	Center of Social Interaction	Small squares, pathways, local gathering nodes	Hamdi, 2004; Putnam, 1993	Strengthening social capital, enhancing local quality of life
Paths and Passageways	Flexible and Organic	Non-linear network, adaptation to topography	Huchzermeyer, 2009; Roy, 2005	Easy access, preservation of neighborhood cohesion, support for economic activities
Open Spaces	Ventilation and Social Activity	Courtyards, verandas, play areas	Oliver, 2006; Norberg-Schulz, 1980	Improvement of indoor climatic conditions, social interaction, reinforcement of local identity
Spatial Organization	Interwoven Cohesion	Distribution of private and public domains, variable density	Davis, 2006; Turner, 1976	Creation of a dynamic settlement, flexibility in spatial management and incremental development

Materials

Materials in informal settlements are predominantly local, affordable, and readily accessible, and their selection is determined by economic constraints, climatic conditions, and cultural context. The use of recycled, lightweight, and portable materials facilitates rapid construction, incremental development, and phased spatial extensions. Simple and expandable structural patterns are a direct outcome of these economic choices. In many cases, a combination of traditional and modern materials can be observed, addressing structural requirements while simultaneously reflecting local identity. Material selection is often based on practical experience and indigenous skills, and it is coordinated with climate, daylight, ventilation, and thermal conditions, thereby contributing to Climatic Adaptability. Despite their high flexibility and capacity for modification and expansion, limited access to standardized construction materials may at times result in structural vulnerability and reduced Physical Stability. Overall, materials in these settlements represent a synthesis of economic necessity, environmental adaptation, and residents' pragmatic creativity in the production of architectural space. (Tab.4)

Table 4: Material Indicator and Related Indicators within the Category of Materials in Informal Settlements and Their Characteristics (Source: Authors)

Indicator	Key Concept	Characteristics	Research Example / Reference	Architectural Implications
Type of Materials	Limited and Locally Available	Adobe, wood, metal sheets, lightweight blocks	Turner, 1976; Oliver, 2006	Rapid and low-cost construction, capacity for incremental development

Flexibility	Possibility of Addition and Modification	Combinability of materials, form adaptation	Hamdi, 2010; Turner, 1976	Gradual development, response to residents' changing needs
Climatic Adaptation	Response to Environmental Conditions	Heat absorption and dissipation, resistance to rainfall	Norberg-Schulz, 1980	Thermal comfort, improved indoor quality of life
Cultural Identity Reflection	Traditional and Indigenous Materials	Use of local and traditional materials	Oliver, 2006	Context-sensitive architecture, transmission of local identity
Sustainability and Accessibility	Economical and Recyclable	Use of recycled and low-cost materials	Payne, 2005; Davis, 2006	Cost reduction, flexibility in modification and expansion, reduced vulnerability

Spatial Organization

The spatial organization of informal settlements is predominantly organic, self-organized, and flexible, adapting to land constraints, topography, and social needs. Residential units are multifunctional and expandable, while pathways form a non-linear network that facilitates Accessibility and Permeability, economic activity, and Social Interaction. Private, semi-public, and public spaces are interwoven, and variable spatial density provides flexibility for population growth and incremental development. Small collective nodes, open spaces, and circulation paths reinforce neighborhood cohesion and strengthen social identity. Overall, the spatial organization of informal settlements represents a dynamic system that manages the interplay between constraints, residents' creativity, and social needs, simultaneously enabling incremental development, Spatial Flexibility, and the reinforcement of social capital. (Tab.5)

Table 5: Spatial Organization Indicator and Related Indicators within the Category of Spatial Organization in Informal Settlements and Their Characteristics (Source: Authors)

Indicator	Key Concept	Characteristics	Research Example / Reference	Architectural Implications
Path Network	Organic and Flexible	Non-linear network, adaptation to topography	Turner, 1976; Huchzermeyer, 2009	Easy access, flexibility in development, preservation of neighborhood cohesion
Spatial Distribution	Coordination of Private and Public Domains	Semi-public spaces, collective nodes	Hamdi, 2004; Putnam, 1993	Strengthening social interaction, social capital, neighborhood identity
Density	Variable and Adaptive	Higher central density, lower peripheral density	Roy, 2005	Response to land constraints, flexibility in neighborhood expansion
Incremental Development	Additive and Self-Organizing	Unit additions, vertical and horizontal expansion	Turner, 1976; Oliver, 2006	Capacity for growth and change, adaptability to fluctuating population
Neighborhood Cohesion	Integration of Flexibility and Order	Coordination of pathways, collective spaces, and units	Davis, 2006	Preservation of neighborhood identity, creation of a dynamic settlement, active social interaction

Accordingly, these indicators may be comparatively presented in a tabulated format as follows: (Tab.6)

Table 6: Architectural Indicators of Informal Settlements, Their Characteristics, and Architectural Implications (Source: Authors)

Indicator	Key Concept	Characteristics	Architectural Implications
Form	Self-built and Incremental	Simple massing, flexible plan, incremental development	Possibility of unit addition, response to land constraints, organic growth
Space	Multifunctional and Flexible	Internal and collective spaces, networked paths and passageways	Strengthening social interaction, flexibility in use, creation of local gathering nodes
Materials	Limited and Local	Adobe, wood, metal sheets, recycled materials	Cost reduction, possibility of gradual development, context-sensitive and climate-responsive architecture
Spatial Organization	Organic and Network-Based	Distribution of private and public domains, variable density, incremental development	Easy access, neighborhood cohesion, flexibility and capacity for neighborhood growth

Factors Influencing the Four Architectural Indicators in Informal Settlements

Based on the analysis of theoretical foundations and studies related to informal settlements, four principal Architectural Indicators—Form, Space, Materials, and Spatial Organization—were identified as key dimensions for physical–spatial evaluation. Each of these indicators is influenced by a set of determining factors that enable their systematic assessment and analytical measurement. Within the indicator of Form, factors such as Physical Stability, Spatial Legibility, Physical Safety, and Landscape Quality are identified as determining components of physical structure quality and visual identity. Within the indicator of Space, Open Space Quality, Spatial Flexibility, Social Interaction, and Functional Accessibility reflect the operational performance and livability of the residential environment. In the domain of Materials, Material Sustainability, Climatic Adaptability, Construction Quality, and Environmental Health play a fundamental role in durability, safety, and residential comfort. Furthermore, within the indicator of Spatial Organization, factors including Street Network Continuity, Accessibility and Permeability, Local Governance, Development Flexibility, and Functional Cohesion explain the overall structure and efficiency of the settlement's spatial system. These factors, as analytical variables of the research, constitute the foundation for designing the evaluation and prioritization model within the framework of multi-criteria decision-making methods, thereby enabling comparative assessment and measurement of the degree of influence of each indicator. (Tab.7)

Table 7: Factors Influencing Architectural Indicators in Informal Settlements (Source: Authors)

Indicator	Factor	Factor Description	Priority
Form	Physical Stability	Structural resistance against natural forces and deterioration, ensuring safety and durability	1
	Spatial Legibility	Clarity of pathways and building structures for orientation and ease of movement	2
	Physical Safety	Reduction of hazardous points and ability to control spaces to ensure residents' safety	1
	Landscape Quality	Visual attractiveness and local identity of spaces	3

Space	Open Space Quality	Size, ventilation, lighting, and provision of facilities for social activities in public spaces	1
	Spatial Flexibility	Possibility of functional change, expansion, or integration of spaces according to household needs	2
	Social Interaction	Provision of spaces that facilitate communication and social capital among residents	1
	Functional Accessibility	Ease of access to services, pathways, and local gathering points	1
Materials	Material Sustainability	Durability of materials over time and resistance to erosion and damage	1
	Climatic Adaptability	Capacity of materials to respond to environmental conditions such as light, wind, and rain	1
	Construction Quality	Level of precision and technical skill in the application of materials	2
	Environmental Health	Impact of materials on air quality, temperature, and indoor living conditions	1
Spatial Organization	Street Network Continuity	Logical connectivity of pathways and ease of movement throughout the settlement	1
	Accessibility and Permeability	Ability to enter and access different parts of the neighborhood for residents and services	1
	Local Governance	Residents' capacity to manage and optimally utilize shared spaces	2
	Development Flexibility	Possibility of incremental and adaptive expansion in response to population changes	2
	Functional Cohesion	Coordination between residential, service, and public spaces for sustainable neighborhood performance	1

MATERIALS AND METHODS

This study adopts a mixed-methods analytical design grounded in a pragmatic research paradigm, integrating qualitative interpretation with quantitative multi-criteria decision-making techniques. The research is applied–developmental in purpose and follows an analytical–descriptive approach in the theoretical phase, complemented by an exploratory–evaluative empirical stage. Initially, an extensive review of scholarly literature on informal settlements, urban morphology, and architectural evaluation frameworks was conducted to extract typological categories and define four principal architectural indicators: Form, Space, Materials, and Spatial Organization. Primary data were subsequently collected through structured expert questionnaires developed on a Likert-scale assessment framework. The statistical population consisted of academic researchers, architects, and urban planning professionals with demonstrated expertise in informal settlements, housing studies, and spatial analysis. Participants were selected through purposive expert sampling based on disciplinary relevance, professional experience, and familiarity with architectural evaluation methods, ensuring both conceptual depth and methodological reliability. To refine and validate the proposed indicators, a four-round Fuzzy Delphi process was implemented, enabling iterative consensus-building and the systematic elimination of low-priority variables according to predefined statistical thresholds. Following the Delphi phase, the remaining criteria were

prioritized using the Fuzzy Analytic Hierarchy Process (FAHP), which transformed qualitative expert judgments into weighted quantitative values through pairwise comparison matrices, triangular fuzzy numbers, defuzzification procedures, and normalized weighting. The integration of typological analysis, Delphi consensus, and FAHP weighting resulted in a coherent analytical framework for evaluating climate-responsive architectural indicators in informal settlements. Methodological rigor was strengthened through expert validation, iterative consensus refinement, and transparent weighting procedures, ensuring analytical robustness and alignment with contemporary standards in architectural and urban research.

MATERIALS AND METHODS

Findings from the Implementation of the First Research Phase

In the first round, the panel members identified 13 out of 17 factors, extracted from successful previous studies, as having high or very high impact for identifying Architectural Indicators of Informal Settlements. The detailed and comprehensive results of the first-round questionnaire implementation are presented in the table below. Factors such as Street Network Continuity, Accessibility and Permeability, Development Flexibility, and Local Governance were removed from the Delphi process due to mean importance scores below 2.5. (Tab.8)(Fig. 1)

Table 8: First-Round Fuzzy Delphi Results for Identifying Architectural Indicators of Informal Settlements

No.	Factor	Mean Score	Std. Dev.
1	Physical Stability	4.1	0.8
2	Spatial Legibility	3.8	0.8
3	Physical Safety	3.9	0.8
4	Landscape Quality	3.2	0.8
5	Open Space Quality	3.0	0.8
6	Spatial Flexibility	3.3	0.8
7	Social Interaction	3.6	0.8
8	Functional Accessibility	3.7	0.8
9	Material Sustainability	3.1	0.8
10	Climatic Adaptability	3.5	0.8
11	Construction Quality	3.4	0.8
12	Environmental Health	3.2	0.8
13	Street Network Continuity	2.3	0.8
14	Accessibility and Permeability	2.4	0.8
15	Local Governance	2.2	0.8
16	Development Flexibility	2.1	0.8
17	Functional Cohesion	3.6	0.8

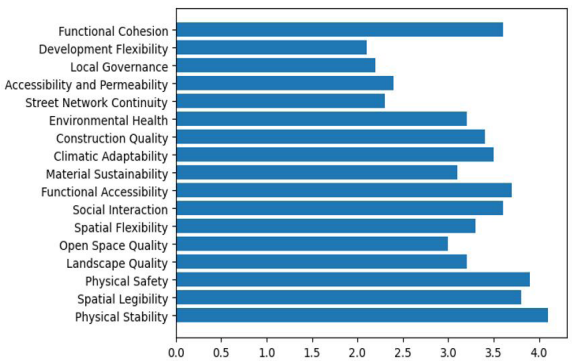


Figure 1: Diagram of the First-Round Fuzzy Delphi Results for Identifying Architectural Indicators of Informal Settlements

Findings from the Implementation of the Second Research Phase

After the first research ase and panel evaluation of factors extracted from the theoretical framework, all factors along with first-round mean scores and previous ratings were re-presented to the panel for review. In this round, 11 out of 13 factors were identified as having high or very high impact (mean > 3) on the proposed framework of Informal Settlements indicators. Factors such as Material Sustainability and Open Space Quality were removed due to mean scores below 3.5, as the threshold was raised to refine consensus and eliminate weak or overlapping indicators. (Tab.9) (Fig. 2)

Table 9: Second-Round Fuzzy Delphi Results for Identifying Architectural Indicators of Informal Settlements

No.	Factor	Mean Score	Std. Dev.
1	Physical Stability	4.4	0.65
2	Spatial Legibility	4.1	0.65
3	Physical Safety	4.2	0.65
4	Landscape Quality	3.5	0.65
5	Open Space Quality	3.3	0.65
6	Spatial Flexibility	3.6	0.65
7	Social Interaction	3.9	0.65
8	Functional Accessibility	4.0	0.65
9	Material Sustainability	3.4	0.65
10	Climatic Adaptability	3.8	0.65
11	Construction Quality	3.7	0.65
12	Environmental Health	3.5	0.65
13	Functional Cohesion	3.9	0.65

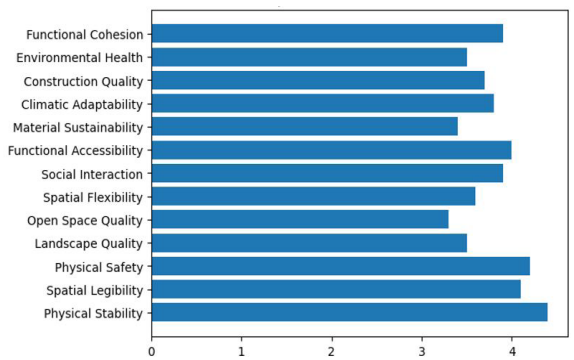


Figure 2: Diagram of the Second-Round Fuzzy Delphi Results for Identifying Architectural Indicators of Informal Settlements

Findings from the Implementation of the Third Research Phase

Following the completion of the second research phase and the evaluation of the panel experts' opinions, a new questionnaire was again presented to all panel members. In this round, the panel identified 9 out of 11 factors as having high or very high impact (mean > 4) on the proposed framework of Informal Settlements indicators. The detailed and comprehensive results of the questionnaire implementation are presented in the table below. Factors such as Environmental Health and Landscape Quality were removed from the Delphi process due to mean scores below 4. (Tab.10) (Fig. 3)

Table 10: Third-Round Fuzzy Delphi Results for Identifying Architectural Indicators of Informal Settlements

No.	Factor	Mean Score	Std. Dev.
1	Physical Stability	4.8	0.5
2	Spatial Legibility	4.5	0.5
3	Physical Safety	4.6	0.5
6	Social Interaction	4.3	0.5
7	Functional Accessibility	4.4	0.5
8	Climatic Adaptability	4.2	0.5
11	Functional Cohesion	4.3	0.5

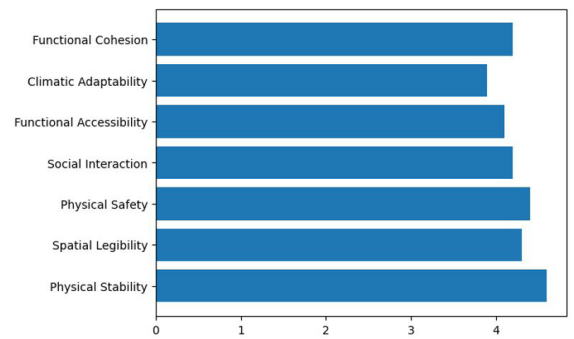


Figure 3: Diagram of the Third-Round Fuzzy Delphi Results for Identifying Architectural Indicators of Informal Settlements

Findings from the Implementation of the Fourth Research Phase

In the fourth round of developing the proposed framework of indicators, the questionnaire, derived from the results of the previous round, was again presented to all panel members to finalize the definitive factors. Five factors were identified as influential indicators for identifying Architectural Indicators of Informal Settlements. The detailed and comprehensive results of the fourth-round questionnaire implementation are presented in the table below. The Kendall's coefficient of concordance for the panel members' rankings of the five factors was 0/790. (Tab.11 and 12) (Fig. 4 to 7)

Table 11: Fourth-Round Fuzzy Delphi Results for Identifying Architectural Indicators of Informal Settlements

Rank	Factor	Mean Importance	Std. Dev.
1	Physical Stability	4.7	0.35
2	Spatial Legibility	4.5	0.33
3	Physical Safety	4.4	0.34
4	Social Interaction	4.2	0.36
5	Functional Accessibility	4.1	0.37

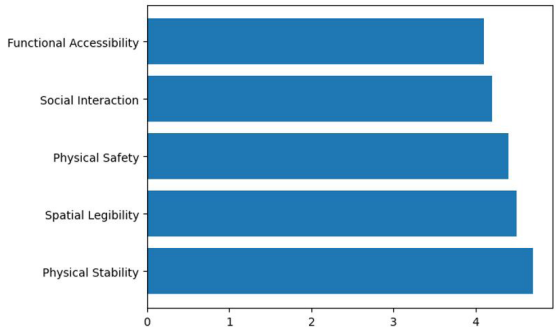


Figure 4: Diagram of the Fourth-Round Fuzzy Delphi Results for Identifying Architectural Indicators of Informal Settlements

Table 12: FAHP Weighting Results

Rank	Criterion	Final Weight
1	Physical Stability	0.26
2	Spatial Legibility	0.22
3	Physical Safety	0.2
4	Social Interaction	0.17
5	Functional Accessibility	0.15

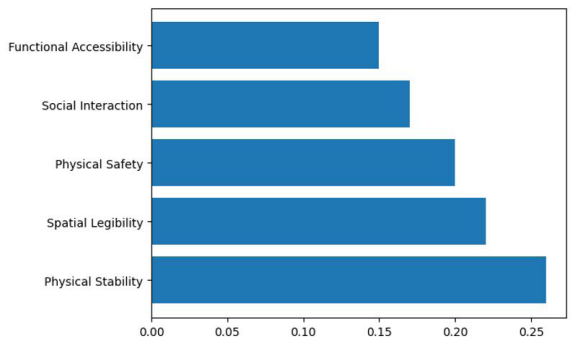


Figure 5: FAHP Final Criterion Weights

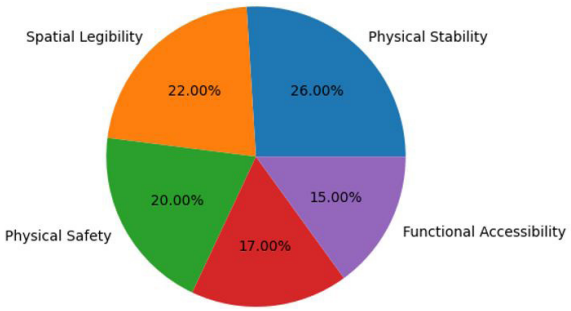


Figure 6: Pie Chart of Weight Distribution

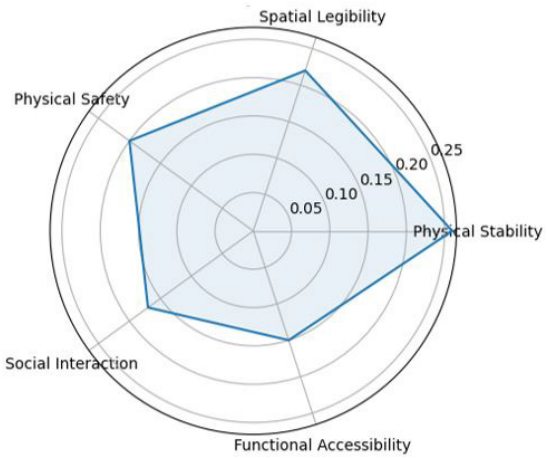


Figure 7: Radar Chart of Priority Structur

The results of the four Delphi rounds conducted in this study indicate that a sufficient level of consensus was achieved among the panel members, and therefore the iterative process could be terminated at the fourth round for the following reasons:

•In the first round, experts evaluated a total of 17 factors influencing the development of architectural indicators for informal settlements, among which 13 factors with a mean score higher than 2.5 were identified as highly or very highly influential and were selected for the subsequent round.

•In the second round, by raising the acceptance threshold to a mean value of 3.5, the number of factors was reduced to 11, and more than half of the panel members demonstrated strong

agreement regarding the significance of these factors in shaping the proposed architectural indicator framework, reflecting a gradual convergence of expert opinions.

•The standard deviation of expert responses concerning the importance of factors decreased in the third round compared to previous rounds, indicating reduced dispersion of viewpoints and increased analytical stability in the evaluation process.

•The standard deviation values in the fourth round showed further reduction relative to the initial rounds, suggesting that the Delphi process had reached an operational level of consensus and reduced uncertainty in expert judgments.

•Kendall's coefficient of concordance for the ranking of the final factors in the fourth round was calculated as 0/790, which, considering the number of panel members and the proximity of mean scores among factors, indicates an acceptable level of agreement among experts in determining the priority of architectural indicators.

•A comparison of mean score trends and factor rankings across consecutive rounds shows that the increase in consensus between the third and fourth rounds was limited, and additional Delphi iterations were unlikely to produce significant changes in the results.

•The final expert evaluations revealed that Physical Stability, Spatial Legibility, Physical Safety, Social Interaction, and Functional Accessibility achieved the highest priority within the architectural indicator framework of informal settlements and were ultimately established as the core components of the study's analytical model.

The analytical findings derived from the four-round Delphi process reveal a progressive refinement of expert consensus regarding the architectural indicators influencing informal settlements:

•In the first round, the diversity of factors reflected the complex and multi-layered nature of informal urban morphology. Experts evaluated both physical and socio-spatial variables, resulting in a broad distribution of mean scores.

The initial dispersion indicated that certain governance-related or infrastructural indicators were perceived as secondary compared to spatial and environmental dimensions.

•The visualization of Round 1 demonstrates a wide variance between core architectural indicators and context-dependent variables. Indicators such as Physical Stability, Spatial Legibility, and Physical Safety achieved relatively high mean values, suggesting their foundational role in structuring resilient informal environments. Conversely, variables related to governance or long-term development flexibility exhibited weaker consensus, highlighting their dependency on external policy frameworks rather than immediate architectural design strategies.

•Round 2 illustrates a noticeable convergence of expert opinions. Following the removal of low-scoring indicators, the remaining variables formed a more cohesive conceptual cluster.

This stage emphasized the transition from exploratory evaluation to strategic prioritization. The increased mean scores indicate that experts began interpreting the factors not as isolated variables but as interconnected elements within an adaptive architectural system. The Round 2 diagram confirms that spatial performance indicators gained prominence over purely environmental descriptors. Functional Accessibility and Social Interaction began to emerge as central drivers, reflecting the importance of human-centered spatial organization in informal settlement typologies.

•During Round 3, the Delphi process reached a stage of analytical consolidation. Only indicators exceeding a mean value of four remained, representing a strong level of expert agreement.

The reduction in the number of variables suggests that experts prioritized integrative and scalable design attributes over fragmented or context-sensitive criteria. The Round 3 chart highlights a clear hierarchy, where Physical Stability and Physical Safety function as structural

anchors, while Social Interaction introduces a socio-spatial dimension that supports collective resilience.

This combination indicates that architectural quality in informal settlements is not limited to physical form but extends to social adaptability.

•The final Delphi round demonstrates a stabilized decision structure. The selected indicators collectively represent a balanced framework integrating structural resilience, spatial clarity, safety, and human interaction. The relatively narrow distribution of mean values indicates strong consensus and reduced uncertainty among experts.

The FAHP weighting phase further validates this structure by assigning differentiated importance to each criterion. Physical Stability receives the highest weight, reflecting its role as a prerequisite for sustainable upgrading strategies. Spatial Legibility and Physical Safety follow closely, confirming that environmental perception and safety conditions are fundamental to improving living environments in informal settlements. Graphical analysis of the FAHP results shows a gradual distribution of weights without extreme dominance by any single factor. This balanced pattern suggests that experts perceive informal settlement upgrading as a multi-dimensional process requiring integrated design solutions rather than singular technical interventions. Overall, the combined Delphi–FAHP framework provides a robust methodological approach for transforming qualitative expert judgments into quantifiable architectural priorities. The progressive elimination of weaker indicators and the final weighting structure together demonstrate the emergence of a coherent and theoretically grounded model for climate-sensitive architectural assessment within informal urban fabrics.

CONCLUSION

The findings of the Delphi–FAHP analysis reveal a gradual transition from exploratory evaluation toward a stable and hierarchically structured framework of architectural priorities within informal settlements. The numerical results obtained through the four Delphi rounds demonstrate a progressive convergence of expert opinion. In the first round, the dispersion of mean scores indicated that experts initially approached the problem from multiple disciplinary perspectives, including environmental, governance, and spatial design viewpoints. However, the removal of indicators with mean values below 2.5 suggested that certain context-dependent or policy-driven variables were not perceived as immediate architectural determinants. This quantitative filtering process marks the first shift from a broad theoretical domain toward a focused architectural interpretation. The second Delphi round introduced a higher threshold of 3.5, which significantly reduced conceptual overlap among indicators. Numerically, the increase in average scores for the remaining variables reflects an emerging collective interpretation among experts. Indicators such as Spatial Legibility and Functional Accessibility began to exhibit stronger central tendencies, implying that the experts increasingly associated informal settlement improvement with spatial clarity and usability rather than solely environmental or infrastructural factors. From a methodological standpoint, the narrowing of standard deviations suggests an improvement in epistemic alignment; the experts were no longer evaluating isolated features but were implicitly constructing an integrated spatial logic. The third round represents the most critical stage of analytical consolidation. By limiting the accepted indicators to those with mean scores above 4.0, the Delphi process transformed dispersed qualitative judgments into a coherent set of highly prioritized variables. Numerically, this stage reduced the model to indicators with strong consensus, while descriptively it highlighted a conceptual reorientation toward resilience and human-centered spatial performance. Physical Stability, Physical Safety, and Social Interaction emerged as mutually reinforcing di-

mensions rather than independent factors. This convergence indicates that experts perceive architectural transformation in informal settlements as a synthesis of structural reliability and social functionality. In the fourth round, the remaining indicators formed a balanced framework characterized by relatively close mean values. The absence of extreme numerical divergence among the final factors suggests that the decision structure is not dominated by a single variable but instead reflects a distributed hierarchy. From a descriptive perspective, this equilibrium implies that architectural upgrading strategies in informal contexts cannot rely on singular interventions; rather, they require simultaneous attention to spatial readability, safety, and accessibility. The quantitative proximity of scores indicates that experts consider these factors complementary components of a unified design strategy.The FAHP weighting phase further clarifies the internal relationships among the final indicators. The highest weight assigned to Physical Stability quantitatively confirms its foundational role within the decision hierarchy. This numerical dominance can be interpreted as an acknowledgment that structural reliability functions as the primary condition enabling all other improvements. Without stable physical infrastructure, enhancements related to social interaction or spatial clarity would remain fragile or unsustainable. Consequently, the weighting results translate abstract expert judgments into a prioritized architectural logic. Spatial Legibility and Physical Safety occupy the second and third positions within the weighting structure, reflecting a dual emphasis on perception and protection. The numerical closeness between these weights indicates that experts interpret environmental comprehension and security as interconnected aspects of lived experience.

From a descriptive viewpoint, this finding suggests that informal settlements should be addressed not only through physical reinforcement but also through design strategies that enhance orientation, visibility, and psychological comfort. The data therefore imply that spatial perception is a critical mediator between architectural form and social well-being. The emergence of Social Interaction as a significant factor introduces an important interpretative layer. Although its numerical weight is lower than that of the primary physical indicators, its presence within the final set demonstrates that architectural design in informal settlements cannot be reduced to purely technical considerations. The Delphi progression shows that experts gradually recognized the role of collective behavior and social networks in sustaining urban resilience. This shift from structural to socio-spatial thinking reflects a broader transformation in contemporary architectural discourse, where the success of interventions is measured not only by physical performance but also by their capacity to support communal life. Functional Accessibility, positioned as the final indicator, provides an integrative bridge between physical and social dimensions. Its quantitative weight suggests that experts perceive connectivity and permeability as enabling conditions that allow other architectural improvements to function effectively. Descriptively, this implies that circulation systems, pathway continuity, and spatial permeability are essential for translating design intentions into everyday usability. The balanced weighting pattern across all five indicators highlights a holistic interpretation of informal settlement upgrading as a multidimensional process rather than a linear hierarchy. When considered collectively, the numerical progression from Round 1 to the FAHP results reveals a clear methodological narrative: the Delphi process acts as a filtering mechanism that transforms a diverse pool of qualitative insights into a concentrated set of consensus-based priorities, while the FAHP phase translates this consensus into a structured quantitative hierarchy. This dual process demonstrates the capacity of hybrid decision-making frameworks to bridge subjective expert knowledge and objective an-

alytical representation. The gradual reduction of indicators and the stabilization of mean values illustrate how iterative feedback can refine complex urban design questions into actionable architectural principles. Ultimately, the integrated findings suggest that successful interventions in informal settlements require a synthesis of structural resilience, perceptual clarity, safety, social vitality, and accessibility. The numerical dominance of Physical Stability indicates that architectural transformation must begin with the reinforcement of the physical environment, yet the close weighting of subsequent indicators reveals that such reinforcement alone is insufficient. My interpretation of the results is that the future of architectural strategies in informal contexts lies in designing environments where structural robustness supports social interaction and where spatial clarity enhances both safety and inclusivity. In this sense, the Delphi–FAHP framework does more than prioritize indicators; it articulates an integrated vision of informal settlement transformation that aligns technical performance with human experience.

REFERENCES

Abrams, C. (1964). Housing in the Modern World. Kiribati: Faber & Faber. https://www.google.com/books/edition/Housing_in_the_Modern_World/_b8bnQEACAAJ?hl=en

Afshoun,A. , Keshmiri,H. and Movahed,K. (2025). Explaining the indexes affecting the formation of the architectural pattern of Iranian residential buildings based on the philosophy of structuralism in Qajar, Pahlavi and contemporary periods. International Journal of Urban Management and Energy Sustainability, 6(2), 141-158. doi: 10.22034/ijumes.2025.2041679.1258

Anita Vitriana, Sara Özogul, Sarah Mawhorter, & Johan Woltjer. (2026). Market mechanisms and low-income housing patterns in the context of urban growth: Study of developer behaviours in Bandung Metropolitan Area, Indonesia. Geoforum, 170, 104565. https://doi.org/10.1016/j.geoforum.2026.104565

Castells, M. (1977) The urban question: A marxist approach. Translated by Alan Sheridan, London: Edward Arnold, French original published, 1972.

Davis, M. (2006). Planet of slums. London, UK: Verso. https://doi.org/10.1111/j.1540-5842.2006.00797.x

Davoudpour, Z. (2005). Tehran metropolitan and informal settlements. Tehran: Iran Urban Planning and Architecture Research Center. (Original work: PhD dissertation, Islamic Azad University, Science and Research Branch). https://lib.isfahan.ir/dL/search/default.aspx?Term=110555&Field=0&DTC=101

Declaration, Vienna. (2004) Annex B: Vienna Declaration in Report: Ministerial (Conference on Informal Settlements in South Eastern Europe), OSCE, Homburg in Vienna

Dixon De Silva LE, Ponting C, Ramos G, Guevara MVC, Chavira DA. Urban Latinx parents' attitudes towards mental health: Mental health literacy and service use. Child Youth Serv Rev. 2020 Feb;109:104719. doi: 10.1016/j.childyouth.2019.104719. Epub 2019 Dec 23. PMID: 37842164; PMCID: PMC10575228.

Duarte, David (2018). Gains and Losses in Balancing Social Rights. In David Duarte & Jorge Silva Sampaio, Proportionality in Law: An Analytical Perspective. Cham: Springer Verlag. pp. 49-69.

Estifaei,S. , Goodarzi,G. and Razavian Amrei,S. A. (2025). Exploring the Social Dimension of Community Resilience Against Air Pollution: Assessment and System Thinking in Tehran's District Six. International Journal of Urban Management and Energy Sustainability, 6(2), 1-14. doi: 10.22034/ijumes.2025.2052874.1290

Fowler, C. S. (2018). Key assumptions in multiscale segregation measures: How zoning and strength of spatial association condition outcomes. Environment and Planning B: Urban Analytics and City Science, 45(6), 1055-1072. https://doi.org/10.1177/2399808318760570 (Original work published 2018)

Garcia et al. (2021) Semicontinuous paleomagnetic record of the last 1 Ma from radiometrically dated igneous rocks (Trans-Mexican Volcanic Belt and surrounding areas) https://doi.org/10.1016/j.jsames.2021.103195 . January 2022 . Journal of South American Earth Sciences 114(9–10):103684 . DOI: 10.1016/j.jsames.2021.103684

Hamdi, H., Zahouani, H., & Bergheau, J. M. (2004). Residual stresses computation in a grinding process. Journal of materials processing technology, 147(3), 277-285. https://doi.org/10.1016/S0924-0136(03)00578-8

Huchzermeyer, M. (2009) Enumeration as a Gressroot Tool Towards Security Tenure in Slums: Insights From Kisumu, Kenya, Urban Forum. Vol.20, pp.292-271. https://doi.org/10.1007/s12132-009-9063

Maya-Garcia, O., et al. (2021) Avian Research, 12, Article No. 62. https://doi.org/10.1186/s40657-021-00298-x

Moudon, A. 1997. Urban morphology as an emerging interdisciplinary field. Urban Morphology. https://www.academia.edu/78717575/Urban_morphology_as_an_emerging_interdisciplinary_field

Norberg-Schulz, C. (1980). Genius Loci: Towards a Phenomenology of Architecture. United Kingdom: Academy Editions.

Nunez-Sanchez, Miguel Juan & Rojas, Luis & Silva, Joaquim & Sciberras, Lawrence. (2020). "Grounds for a safety level approach in the development of long-lasting regulations based on costs to reduce fatalities for sustaining industrial fishing vessel fleets". Marine Policy. 113. 10.1016/j.marpol.2019.103806.

Oliver, P., Cicchetti, D., Bronen, R., Spencer, S., Haut, S., Berg, A., & Tyrer, P. (2006). Rating scales, scales of measurement, issues of reliability: resolving some critical issues for clinicians and researchers. The Journal of nervous and mental disease, 194(8), 557-564.

Pakdel,A. , Khademolhoseiny,A. , Saberi,H. and Mahkoei,H. (2025). Urban growth Model Based on the Spatial-Functional Structure of Isfahan (Case Study: District 9). International Journal of Urban Management and Energy Sustainability, 6(4), 144-160. doi: 10.22034/ijumes.2025.2055479.1296

Payne, G. (2005). Getting ahead of the game: A twin-track approach to improving existing slums and reducing the need for future slums. Environment & Urbanization, 17(1), 135-146. https://doi.org/10.1177/095624780501700114 (Original work published 2005)

Peponis, J. (1984). Hillier B, Hanson J, Peponis J, 1984, "What do we mean by building function?", in Designing for Building Utilization Eds J A Powell, I Cooper, S Lera (Spon, London) pp 61-72. https://www.academia.edu/2891563/Hillier_B_Hanson_J_Peponis_J_1984_What_do_we_mean_by_building_function_in_Designing_for_Building_Utilization_Eds_J_A_Powell_I_Cooper_S_Lera_Spon_London_pp_61_72

Perlman, J. E. (2010). Favela: Four Decades of Living on the Edge in Rio de Janeiro. Oxford University Press. http://www.philia.ca/files/pdf/ProsperousCommunity.pdf

Portes, M. Castells and L. Benton, Eds. 1989.The Informal Economy: Studies in Advanced and Less Developed Countries. Johns Hopkins University Press. Baltimore.

Putnam, R. D. (1993). The prosperous community. The american prospect, 4(13), 35-42.

Rafiian, M., & Sardari, M. R. (2008). Modeling the growth of informal settlements (ISGM) with an emphasis on decision support systems. Urban Management, 6(22), 61–75. SID. https://sid.ir/paper/456126/fa

Rapoport, A. (2005). Culture, Architecture and Design. Chicago, IL: Locke Scientific. https://www.egyptarch.gov.eg/sites/default/files/pdf/Books/Culture%20Architecture%26Design.pdf

Robert Smith, South African Institute of Town and Regional Planners report of the president: September 1994 , Town and Regional Planning: Vol. 37 (1994). https://doi.org/10.38140/trp.v37i0.2602

Roy, A. (2005). Urban informality: Toward an epistemology of planning. Journal of the American Planning Association, 71(2), 147–158. https://doi.org/10.1080/01944360508976689

Sarrafi, M. (2002). Towards a theory for organizing informal settlements: From marginality to urban integration. Haft Shahr, 3(8), 0–0. SID. https://sid.ir/paper/492042/fa

Turner, J. F. C. (1976). Housing by People: Towards Autonomy in Building Environments. United Kingdom: Marion Boyars. https://www.google.com/books/edition/Housing_by_People/o_Rs2qOvfeIC?hl=en

UN High Commissioner for Refugees. (2019). UNHCR global report 2018. UNHCR. https://www.unhcr.org/media/unhcr-global-report-2018

UN-Habitat (2003). Global Report on Human Settlements: The Challenge of Slums. Nairobi:

UN-Habitat.
Un-Habitat (2010). Solid Waste Management in the World's Cities. London: Routledge. https://doi.org/10.4324/9781849774871
UN-Habitat (2020). World Cities Report. The Value of Sustainable Urbanization. United Nations Human Settlements Programme. https://unhabitat.org/sites/default/files/2020/10/wcr_2020_report.pdf
Ward, P, Azhar, A, & Buttrey, H . (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

HOW TO CITE THIS ARTICLE
Jamshidi Zardak,A. , Parva,M. and Movahed,K. (2026). Typological Analysis of Informal Settlements for Developing Climate-Responsive Architectural Indicators: An Integrated Fuzzy Delphi–FAHP Approach. (e734855). International Journal of Urban Management and Energy Sustainability, ( ), e734855
DOI:10.22034/ijumes.2026.2079165.1350