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# Analysis of the Impacts of Social & Economic Issues on Housing Physical Indicators (Case Study: The 2<sup>nd</sup> District of Tehran, Iran)

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**Abstract** This study investigates the influence of socio-economic variables on the physical characteristics of housing in District 2 of Tehran, an area marked by pronounced spatial and socio-economic polarization. Employing a mixed-methods quantitative approach, including factor analysis and regression modeling, the research develops a composite index titled "Housing Physical Condition" (HPC) to represent the physical status of residential buildings. Social and economic indicators—such as literacy rate, income-to-housing expenditure ratio, and unit density—were analyzed for their correlation with the HPC index. The results reveal that physical housing quality is strongly shaped by both social structures and economic capacities, with indicators like household literacy and housing cost burdens showing significant explanatory power. The study underscores that physical upgrades alone are insufficient for housing improvement; rather, a multidimensional planning approach that integrates socio-economic interventions is critical to addressing urban disparities. The proposed framework offers valuable insights for inclusive urban housing policies in similarly fragmented metropolitan contexts.

**Index Terms** Housing Planning, Housing Development, Socio-Economic Factors, Physical Indicators, Tehran.

## I. Introduction

Housing is universally recognized as a fundamental human necessity, integral to ensuring individual well-being, family stability, and societal cohesion. Beyond its role as a physical shelter, housing serves as a socio-spatial entity that profoundly shapes the physical, psychological, and social experiences of residents [1]. Its significance transcends the household level, as housing is deeply embedded within broader urban systems and continuously interacts with infrastructure networks, governance frameworks, planning policies, and social dynamics. These interactions both reflect and actively reinforce patterns of spatial organization, social stratification, and economic vitality within cities. Consequently, housing functions not only as a residential asset but also as a critical analytical lens through which processes of urban development, socio-spatial inequality, and uneven access to urban resources can be better understood.

As articulated by Dunn (2020), housing is a multi-dimensional phenomenon encompassing economic, social, cultural, environmental, and physical attributes. These dimensions operate synergistically to determine quality of life for individuals and communities while shaping urban identity, spatial morphology, and social hierarchies. For instance, economic factors shape housing affordability and market dynamics, while social elements influence access equity, residential stability, and community cohesion [2]. Cultural aspects further guide lifestyle preferences and housing choices, environmental considerations affect sustainability and long-term resilience, and physical characteristics—such as construction quality, safety, and spatial layout—directly determine habitability and overall living standards [3]. Collectively, these interrelated dimensions highlight housing as a central concern in public discourse and policy-making, given its far-reaching implications for social welfare and its substantial contribution to national economies through job creation, capital mobilization, and strong interconnections with sectors such as construction, finance, urban infrastructure development, and long-term socio-economic growth [4].

Within the paradigm of sustainable urban development, housing and urban planning occupy a strategic and interdependent position. Urban planning extends beyond technical design and regulatory compliance, functioning as a key instrument for promoting spatial justice, economic efficiency, and environmental sustainability. The growing complexity of housing demands—driven by demographic transitions, rapid urbanization, and shifting socio-cultural expectations—calls for comprehensive and adaptive planning approaches [1], [4]. These approaches must effectively integrate residential development with transportation systems, infrastructure provision, environmental management, and socio-cultural services to ensure balanced and inclusive urban growth. In the absence of such holistic frameworks, socio-spatial inequalities are often intensified, leading to persistent challenges such as informal settlements, overcrowding, inefficient land use, and declining urban liveability.

These issues are particularly acute in rapidly urbanizing contexts, especially in developing and transitional economies,

where housing shortages and socio-spatial inequalities are compounded by population pressures and resource constraints. In Iran, Tehran exemplifies these dynamics, having experienced sustained population growth fuelled by natural increase and rural-to-urban migration, with its population rising from approximately 8.7 million in 2011 to over 9 million by 2016 [2], [5]. This demographic surge has significantly intensified housing demand, placing considerable pressure on urban infrastructure and deepening inequalities in access to adequate and high-quality housing. Socio-economic factors—such as income disparities, employment structures, and household purchasing power—directly shape physical housing characteristics, including construction quality, residential density, and spatial organization [2], [5]. As a result, these interconnected dynamics reinforce socio-spatial polarization within cities, further exacerbating intra-urban inequalities and uneven patterns of urban development.

The historical evolution of family structures—from extended kinship systems in the 19th century to nuclear households in the 20th and 21st centuries—combined with rising household incomes and changing lifestyle expectations, has significantly amplified housing demand [3]. Concurrently, the gradual retreat of state-led housing provision in Iran has shifted the primary responsibility for housing development from public authorities to private developers and individual households, making access to adequate housing increasingly dependent on economic means and social positioning. This transition has amplified social and spatial disparities, as households with limited financial resources or lower socio-economic status face greater difficulty in securing safe, durable, and appropriately located homes.

The reliance on private markets has not only constrained affordable housing supply but also reinforced patterns of urban segregation, leaving low-income families disproportionately exposed to substandard living conditions, overcrowding, and limited access to essential services [1], [3]. As a result, housing has become a key site where broader social inequalities are both reflected and reproduced, highlighting the urgent need for integrated policies that address economic, social, and spatial dimensions of urban inequality.

Housing, therefore, must be reconceptualised as a critical component of urban transformation processes, where socio-economic variables dynamically interact with physical attributes to shape the development and livability of cities. This complex interaction has emerged as a central focus of contemporary urban research, especially in contexts marked by pronounced social and economic inequality. Tehran's District 2 provides a particularly compelling case study, exhibiting stark north-south disparities clearly delineated by the Hemmat Highway. These disparities are evident in unequal patterns of income distribution, differential access to urban services, variations in housing quality, and distinct cultural practices, all of which reflect and reinforce broader socio-economic divides. Understanding these localized dynamics is crucial for developing equitable urban policies, targeted interventions, and planning strategies that address both structural and social dimensions of urban inequality.

## II. Literature Review

Housing, as a fundamental pillar of urban life, goes beyond serving as a basic human need, operating instead as a complex, multifaceted system where social, economic, and physical dimensions continuously interact and influence one another, collectively shaping the quality of life, urban form, and patterns of social equity within cities. This concept is recognized as a foundation for shaping social identity, fostering community cohesion, and achieving economic-spatial justice. Unlike the traditional one-dimensional perspective that views housing solely as a physical unit, contemporary approaches in urban studies—particularly following the OECD report in 2023—emphasize that housing constitutes a "complex system" that both reflects and shapes broader socio-economic structures. This complex system is influenced by macro-level housing policies while simultaneously serving as a determinant factor in urban dynamics [4]. Such a perspective necessitates the simultaneous examination of the three core dimensions of housing.

### II. A. The Social Aspect of Housing

Although housing today encompasses far more than a basic human need—and in many cases its economic dimension has become dominant—its social and cultural aspects remain deeply influential. The condition of housing significantly shapes not only individual well-being but also the quality of life at the neighbourhood level. Residential environments influence residents' social opportunities, economic mobility, and access to urban resources. Research over recent decades has shown that neighbourhood quality affects not only subjective satisfaction but also measurable outcomes such as employment. For instance, O'Regan and Quigley found that residential location accounted for 10 to 40 percent of racial disparities in youth employment outcomes [5].

The emergence of informal settlements or shanty towns frequently results from the neglect of vulnerable populations in urban development planning. When the housing needs of low-income groups are overlooked, it creates unmet demand, forces residents into substandard housing, and limits their access to essential services such as water, sanitation, and education. This social deprivation is reflected spatially, with poorly serviced and overcrowded neighbourhoods highlighting structural inequalities, thereby reinforcing and deepening existing patterns of urban inequality and socio-economic marginalization.

Analyzing the social aspects of housing is therefore crucial for understanding the broader dynamics of housing systems. It helps identify the underlying parameters that shape housing demand and supports more effective planning and decision-

making [6]. Social and cultural factors play a significant role in shaping household preferences and the trade-offs they make when choosing housing types and locations. These factors encompass proximity to family and social networks, emotional attachments to familiar or culturally significant places, and practical considerations such as ease of access to employment opportunities, educational institutions, healthcare facilities, and transportation infrastructure, all of which collectively influence residential choices and neighbourhood selection. For many groups, particularly Indigenous communities, place also carries cultural and spiritual meaning [7].

Despite their importance, social dimensions of housing are often overlooked in scenario-building and urban planning models—partly because they are more difficult to quantify and predict [4]. Yet social criteria such as security, desirability, and affordability remain central to how people experience housing. These factors are shaped by household values, priorities, and expectations. People seek housing that is not only affordable and secure, but also well-located and supported by appropriate infrastructure. A house, therefore, is not merely a physical unit; it must be embedded in a liveable environment that provides access to employment, education, healthcare, reliable water supply, sanitation, cultural and recreational amenities, and supportive social infrastructure. Only such a comprehensive approach to housing can fulfil its social function and promote urban inclusion [6], [7].

## ***II. B. The Economic Aspect of Housing***

In many developing countries, housing problems are primarily quantitative rather than qualitative, due to rapid urbanization and the significant gap between housing demand and supply [1]. Economic and financial conditions—whether at the macro level of national markets or the micro level of individual households—directly influence housing construction patterns and residential choices. For instance, in highly commercialized housing markets, increasing density is often pursued to maximize the number of units sold, enabling developers to recover costs and secure profits. In cases where housing is built on public land without formal ownership, occupants are often required to purchase the land to obtain legal tenure prior to redevelopment [8].

Housing affordability is typically defined as housing costs consuming no more than 30% of a household's gross income. While this benchmark offers an objective standard, it does not reflect housing quality. Economically disadvantaged households may reside in overcrowded or deteriorating rental units simply to reduce costs. Although these conditions are technically "affordable," they can severely undermine well-being and contribute to social problems [9].

Access to housing is shaped by broader market dynamics, including household income and wealth, prevailing price and rent levels, and the overall supply-demand balance within local real estate markets, all of which determine the ability of individuals and families to secure adequate and affordable homes. Public policy also plays a crucial role—from direct interventions such as the allocation of social housing, to indirect tools like land-use planning and zoning regulations [7], [9].

Land and housing price estimation is a key concern for urban planners and policy-makers. Accurate price estimation not only reflects current supply-demand conditions but also helps identify the share of each contributing factor—land acquisition, development costs, marketing expenses, and profit margins. In many urban contexts, housing price inflation is driven largely by limited land availability and rising land values [10].

Housing is both the largest consumption item and the most important asset for most households. Fluctuations in housing prices affect affordability, household equity, and mobility, with rising prices boosting homeowners' equity and borrowing capacity while reducing renters' purchasing power. Renters, especially in cases of stagnant income, may be forced to continue renting or relocate to areas with lower housing costs [9], [11].

Furthermore, housing expenditure is highly inelastic, meaning that low-income households have limited flexibility to reduce their housing costs during periods of financial strain. Adjusting housing consumption often requires relocating, a process that involves substantial financial, logistical, and emotional burdens, making it a costly and challenging option for vulnerable families. [12].

Government subsidies are another key economic factor. In many developed countries with well-functioning housing systems, the ratio of average house price to household income remains relatively low. In contrast, this ratio is often extremely high in developing countries, posing serious affordability challenges. Poorly targeted subsidies—whether for producers or consumers—can distort the market and lead to policy inefficiencies. Therefore, housing subsidies must be clearly defined, well-targeted, and integrated into efficient policy frameworks to avoid unintended negative consequences.

Finally, housing is not only a consumption good but also a productive long-term investment. It generates a flow of services and stimulates other sectors in the economy. Empirical evidence supports the positive relationship between capital investment in housing, economic growth, and market stability [13].

Economic indicators of housing serve as measurable tools to assess and compare housing conditions across time and space. They provide essential insights for policy-making and allow planners to monitor trends and guide effective interventions.

## ***II. C. The Physical Aspect of Housing***

Housing plays a crucial role in shaping the physical dimension of place through factors such as design, style, type, size, quality, and state of repair [7], [11]. Issues of insecure tenure and housing unaffordability often lead to poor living conditions for

disadvantaged populations. These conditions commonly include substandard housing structures located on contaminated or disaster-prone sites, combined with a lack of basic services, disproportionately exposing low-income communities to elevated physical and social risks.

In the context of rapid urbanization, the built environment is a key determinant of social and physical liveability, influencing residents' daily experiences, access to services, and overall quality of life. It is essential to investigate how the built environment influences social liveability indicators such as privacy, safety, security, and social cohesion. Equally important is the study of its impact on physical liveability indicators including air quality, ventilation, and thermal comfort, all of which directly affect occupant health [14].

Housing is not merely a physical shelter but also significantly impacts individuals' physical, mental, and emotional well-being, shaped by both the qualitative aspects of the housing condition and the surrounding environment. The World Health Organization (WHO) defines "sick building syndrome" as a set of non-specific symptoms—including eye, nose, or throat irritation, skin problems, headaches, nausea, and other hypersensitivity reactions—often linked to building materials and inadequate ventilation. Poor ventilation can result from design flaws such as low ceilings, absence of windows or air wells, and proximity to adjacent buildings—all common in low-cost housing worldwide.

The urban poor face the highest health risks globally, with overcrowding (defined as more than two persons per room) frequently cited as a key housing condition indicator. Poor physical housing conditions—such as pest infestations, plumbing defects, and inadequate heating or cooling—contribute to mental health issues including depression, anxiety, sadness, helplessness, and emotional distress. Additionally, the surrounding environment plays a critical role; many low-income and informal settlements lack sufficient communal and recreational spaces like multipurpose halls or playgrounds [15], [16].

Poor physical design of housing can increase the risk of accidents like trips, slips, and falls, as well as physical injuries. It may also adversely affect psychological well-being through various mechanisms [12]. Physical aspects of housing can be examined from two perspectives. First, the physical characteristics of the housing unit itself—encompassing construction, materials, and technology [16]—as well as climate considerations. The interaction between dwelling and climate involves seasonal adaptations, such as distinct summer and winter housing forms (ibid).

Second, the relationship between housing and its residential environment, which acts as a social indicator reflecting the role and status of housing in urban development. Location is crucial because place conditions largely determine housing characteristics. Residential needs and behaviours demand specific dwelling forms and functional spaces that vary according to the socio-economic profiles of residents. For instance, individuals with different income levels tend to reside in distinct urban zones [17]. Housing consumption models, both in goals and policies, have significant physical impacts. Activities once conducted outside the home increasingly occur within, requiring dedicated spaces [18].

The exterior physical characteristics of housing are also highly important. Housing substantially shapes urban environments and city form. Historically and contemporarily, alongside the natural environment, housing has been a major factor in urban development. Rapid population growth from natural increase and migration, along with changes in household structure and size, has driven significant physical expansion of cities. Residential zones comprise the largest city sectors, and housing production quantitatively determines urban physical development [16], [19].

### III. Methodology

This study adopts a quantitative methodological framework to analyze the relationship between socio-economic conditions and the physical characteristics of housing. The methodology involves constructing a composite index representing Housing Physical Condition (HPC) through factor analysis, followed by regression modeling to evaluate the influence of selected socio-economic variables, providing a systematic and data-driven understanding of how social and economic factors shape housing quality, while offering insights that can inform targeted urban planning and housing policy interventions.

#### III. A. Assessing Housing Conditions through Social, Economic, and Physical Indicators: A Factor and Regression Analysis Approach

Due to constraints in data availability and the need for comparability, a selected set of measurable indicators was used to represent the social, economic, and physical dimensions of housing. Social indicators included variables such as the number of families per statistical unit, total population, percentage of active population, literacy rate, sex ratio, distance to the nearest school, distance to the nearest medical center, net population density, and average number of persons per room. Economic indicators encompassed the share of housing costs in family income and expenditures, employment and unemployment rates, and annual housing price inflation. Physical indicators included building area, number of floors, building height, number of rooms per unit, parcel grain (fine or coarse), structural stability, and urban compactness or impermeability.

In the first stage, factor analysis was employed to combine selected physical indicators into a single composite measure, termed the Housing Physical Condition (HPC) index. In the second stage, this index was statistically tested against social and economic variables through regression analysis to determine their relative influence. This two-step approach provided

a comprehensive and systematic understanding of how socio-economic disparities are manifested in the physical quality of housing, highlighting the interplay between economic capacity, social factors, and residential conditions.

### **III. B. Study Area: Housing Conditions in District 2 of Tehran**

District 2 is one of Tehran's 22 municipal districts, situated in the northern part of the city and stretching longitudinally from the Alborz Mountains in the north (elevation  $\sim$ 1800 meters) down to the southern lowlands (elevation  $\sim$ 1200 meters). Its location creates diverse topographical and environmental conditions, including mountainous areas, hills shaped by water erosion (such as those in Pardisan Park), and small valleys like Darakeh and Farahzad, contributing to varied urban morphology and living conditions within the district.

According to the 2016 census by the Statistical Center of Iran, Tehran had a population of 8,693,706 residents and 2,911,065 households—a 13% increase compared to 2006 [2]. This population growth is driven by a combination of natural increase and substantial rural-to-urban migration, reflecting the city's ongoing urbanization and demographic expansion, which in turn places increasing pressure on housing, infrastructure, and urban services throughout the metropolitan area. The transformation in family structure—from extended to nuclear families—has increased demand for housing, even in the absence of equivalent population growth. Simultaneously, the government's reduced involvement in housing production [20] has shifted responsibility to private developers, thereby making housing access increasingly dependent on household socio-economic capacity.

District 2 lacks significant historical monuments, but villages such as Tarasht, Evin, and Farahzad represent the district's rural past and have organically evolved into urban neighborhoods. These areas display a diverse mix of urban morphology, housing typologies, and varying levels of physical development, which makes District 2 an ideal setting for examining socio-economic disparities and understanding how these differences are reflected in the quality, design, and distribution of housing across the district.

### **III. C. Consideration of Housing Indicators in The 2<sup>nd</sup> District of Tehran**

Tehran, the capital of Iran, is officially divided into 22 municipal districts, with District 2 selected as the case area for evaluating housing development indicators. Located among the five northern, mountainside districts, District 2 has an elongated rectangular shape, stretching from the Alborz Mountains in the north at approximately 1800 meters above sea level down to the southern lowlands around 1200 meters. This north-south gradient creates varying slopes and diverse topographical and environmental conditions, shaping both the urban form and the distribution of housing quality throughout the district.

The district's varied terrain influences building types, density patterns, and infrastructure development, while the differences in elevation and accessibility contribute to distinct socio-economic divisions. These geographic and environmental characteristics make District 2 particularly suitable for analyzing how topography and urban planning intersect with social and economic disparities in housing, providing a rich context to study the spatial distribution of residential quality and the impact of planning policies on different communities. In the figure below, the location of the study area relative to the other districts of Tehran is illustrated (Figure 1).



Figure 1: location of the 2nd district in Tehran.

The Alborz mountain range forms the northern boundary of District 2, creating a striking natural backdrop that shapes the district's topography and microclimates. Several small valleys, such as Darakeh and Farahzad, lie along the northern mountainside with varying depths and gentle slopes, while numerous hills, including those in Pardisan Park and northern Gisha, have formed in the central zone through long-term water erosion processes. These geographic features have historically dictated settlement patterns, infrastructure placement, and land use, contributing to a spatial hierarchy within the district. Historical investigations reveal that District 2 lacks a long-standing urban heritage and is not known for major historical

landmarks. However, three key areas—Tarasht, Evin, and Farahzad—stand out historically, exhibiting organic, village-like urban morphologies that reflect their rural origins before integration into the city’s modern urban fabric. These neighbourhoods illustrate how traditional rural layouts have gradually been modified to accommodate expanding urban needs, offering valuable insight into the district’s socio-spatial evolution and its dynamic relationship with both natural landscapes and the built environment. The following figure depicts the spatial structure and urban fabric of District 2 (Figure 2).

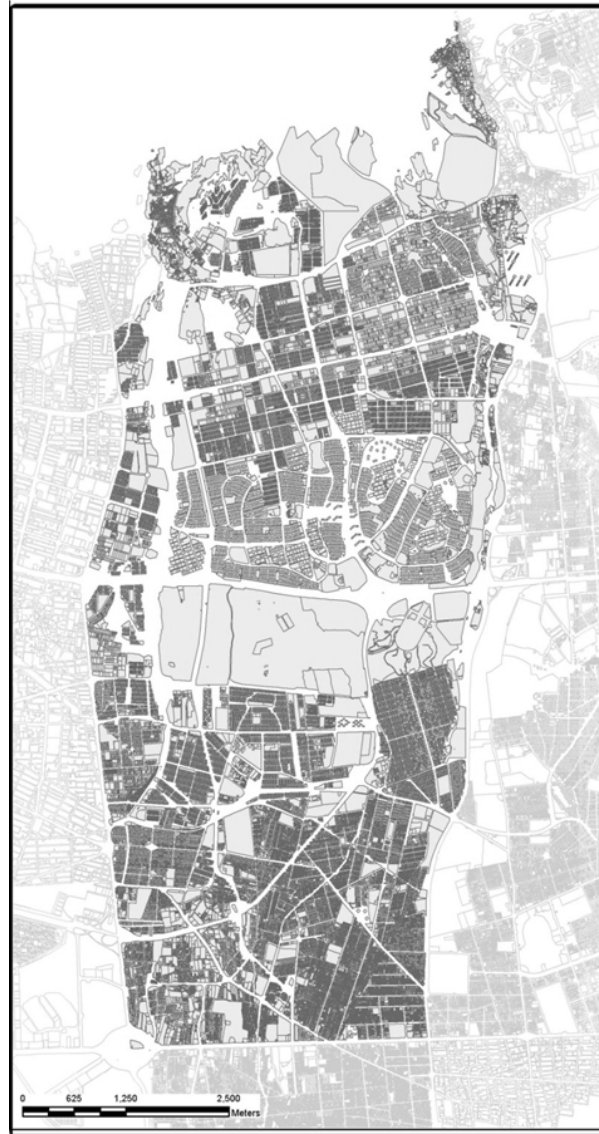


Figure 2: the 2nd district of Tehran.

#### **IV. Analysis of the Impacts of Social and Economic Issues on the Physical Indicators of Housing**

This section investigates the influence of socio-economic factors on the physical characteristics of housing in Tehran’s District 2, employing a robust, multi-stage analytical framework. A composite index, termed the Housing Physical Condition (HPC), was developed to encapsulate the physical quality of residential structures, enabling a systematic evaluation of its relationships with social and economic variables. The analysis integrates data harmonization, indicator weighting, and statistical modeling to provide evidence-based insights into the interplay between socio-economic dynamics and housing quality, with a particular focus on addressing the editorial feedback regarding the depth of explanation for the selected physical indicators.

##### **IV. A. Construction of the Analytical Database**

The analytical framework of this study is grounded in a comprehensive database compiled from multiple authoritative sources, ensuring both robustness and methodological reliability. Data were obtained from the Detailed Plan of District 2 [21], [22],

the 2016 National Census [2], and the Tehran Comprehensive Plan (2007). Collectively, these datasets provided detailed and multi-dimensional information on social, economic, and physical indicators across different spatial scales, including parcels, blocks, and statistical areas, enabling a comprehensive assessment of housing conditions and their spatial distribution patterns [23].

To establish analytical consistency, all datasets were carefully harmonized and aggregated to the statistical area level using the Spatial Join function in ArcGIS. This procedure ensured proper alignment of spatial units, enabling a coherent and directly comparable assessment across diverse indicators. Additionally, the process incorporated georeferencing and standardization measures to address discrepancies in spatial granularity and ensure methodological rigor.

As a result, social indicators (e.g., literacy rate, population density), economic indicators (e.g., housing expenditure as a share of household income), and physical indicators (e.g., building floor area, structural stability) were rendered directly comparable across the study area, allowing for meaningful cross-variable analyses. The resulting integrated database thus provided a robust empirical foundation for subsequent analyses, supporting a spatially explicit and methodologically rigorous investigation of housing dynamics within District 2 of Tehran. Moreover, this harmonized dataset enabled the identification of spatial patterns, disparities, and correlations that might otherwise have been obscured by inconsistent or fragmented data sources, ensuring that policy-relevant insights could be reliably drawn from the study and providing a robust foundation for evidence-based urban planning decisions.

#### **IV. B. Development of the Housing Physical Condition (HPC) Index**

The creation of the Housing Physical Condition (HPC) index was a critical step in synthesizing the physical attributes of housing into a single, quantifiable measure, enabling the examination of their relationships with socio-economic variables. The development of the HPC index followed a structured, multi-step process grounded in methodological rigor and informed by established urban studies frameworks [12], [16], [24]. The process is detailed below, with a particular emphasis on addressing the editorial feedback regarding the insufficient depth in explaining the selected indicators.

##### **IV. B. 1) Selection and Conceptual Justification of Physical Indicators**

A comprehensive review of potential physical indicators was conducted to identify variables that robustly represent the multifaceted nature of housing quality. Seven indicators were selected based on their theoretical relevance to housing functionality, empirical measurability through available data, and alignment with prior urban housing studies [7], [17], [25]. These indicators, detailed below, collectively capture the physical quality, structural integrity, and environmental adaptability of housing units in District 2:

- *Building Area*: This indicator measures the total floor area of a residential unit (in square meters), reflecting spatial capacity and functional adequacy. Larger building areas are associated with greater livability, as they provide more space for household activities and privacy, which are critical for resident well-being [1]. Data were sourced from municipal records and field surveys conducted as part of the Detailed Plan of District 2 [21].
- *Number of Floors*: The number of floors in a building serves as a proxy for building scale and typology, influencing both structural design and urban density. Multi-story buildings often indicate higher-density urban environments, which may correlate with socio-economic pressures such as land scarcity. This indicator was derived from building permit data and verified through field observations [22], [25].
- *Building Height*: Measured in meters, building height complements the number of floors and provides insights into structural and aesthetic characteristics. Taller buildings may reflect modern construction practices but can also exacerbate issues like overcrowding or reduced ventilation in dense urban settings [12]. Data were obtained from municipal planning records and topographic surveys.
- *Number of Rooms per Dwelling*: This indicator quantifies the internal spatial organization of a housing unit, directly impacting functional livability and privacy. A higher number of rooms typically indicates better accommodation for household needs, particularly for larger or nuclear families prevalent in District 2 [3]. Data were extracted from the 2016 National Census and cross-validated with survey data.
- *Structural Stability*: This indicator assesses the physical integrity and safety of a building, measured through engineering assessments of material quality and construction standards. Stable structures are less prone to damage from environmental stressors (e.g., earthquakes), which is critical in Tehran's seismically active context. Data were sourced from municipal inspections and engineering reports [12], [16].
- *Impermeability of the Urban Fabric*: This measures the resistance of building structures to environmental stressors, such as water infiltration or thermal loss, which affects long-term durability and occupant comfort. Impermeability was assessed through field surveys evaluating building materials and design features like roofing and insulation [7], [22].
- *Grain Fineness (Microlithivness)*: This indicator captures the density and arrangement of urban fabric elements, influencing microclimate, ventilation, and spatial organization. Fine-grained urban fabrics, characterized by smaller parcels and

tighter layouts, often correlate with higher density and socio-economic constraints [7]. Data were derived from GIS-based parcel analysis and urban morphology studies.

These indicators were carefully selected to provide a comprehensive representation of the physical condition of housing, encompassing both internal features, such as the number of rooms and overall floor layout, and external characteristics, including building material impermeability and the fineness of the urban grain. By integrating these diverse aspects, the HPC index is able to capture the full spectrum of housing quality, from fundamental structural stability and safety to functional spatial organization and livability.

This multidimensional approach not only aligns with the perspective advocated by Dunn (2020) but also ensures that the index can serve as a reliable tool for analyzing how different physical attributes collectively influence residents' well-being and the overall performance of the urban housing system. Furthermore, the inclusion of both micro-level (building-specific) and meso-level (neighborhood-scale) indicators allows for nuanced spatial analyses that can inform targeted planning and policy interventions, supporting evidence-based decision-making and prioritization of resources to improve housing quality across diverse socio-economic contexts.

**IV. B. 2) Weighting of Physical Indicators Using the Analytic Hierarchy Process (AHP)**

Given the heterogeneous contribution of each indicator to overall housing quality, it was necessary to assign relative weights that reflect their comparative importance. To achieve this, the Analytic Hierarchy Process (AHP), originally developed by Thomas L. Saaty, was applied to ensure a systematic, transparent, and replicable weighting procedure [23], [24]. AHP employs pairwise comparisons to quantify expert judgments, thereby minimizing subjectivity and enhancing methodological consistency through the application of a consistency ratio test.

In this study, a panel of urban planning and housing experts conducted the pairwise comparisons to evaluate the relative significance of each physical indicator in determining housing quality. For instance, structural stability was assigned greater importance than microlithiveness, owing to its direct implications for safety within Tehran's seismically active context, as well as its influence on long-term durability, maintenance costs, and overall resident confidence in housing reliability, highlighting how certain physical attributes play a critical role not only in immediate habitability but also in shaping the resilience and sustainability of the urban housing stock over time.

The results of this process are presented in Table 1, which reports the importance coefficients derived from AHP, together with the numerical averages of rows and row multiplications used to generate normalized weights. These coefficients provide an interpretable measure of the relative contribution of each indicator, allowing researchers and policymakers to clearly understand which physical attributes most strongly influence housing quality and to prioritize interventions accordingly (Table 1).

Table 1: The calculation of the importance coefficients of the studied physical indicators

Housing Physical Condition	Area	Number of Floors	Build. Height	Number of Room per Unit	Microlithiveness	Stability of Structure	Impermeability of Text	Row Multiplication	Numerical Average of Rows	$\epsilon$
Area	1	5	7	1/3	5	1/7	1/5	1.617	1.0695	0.40984
Number of Floors	1/5	1	5	1/5	3	1/9	1/7	0.00924	0.5190	0.27021
Build. Height	1/7	1/5	1	1/7	1/3	1/7	1/5	3.62208E-05	0.2389	0.12981
Number of Room per Unit	3	5	7	1	5	1/5	1/5	21	1.5314	0.09069
Microlithiveness	1/5	1/3	3	1/5	1	1/7	1/3	0.00182952	0.4137	0.04411
Stability of Structure	7	9	7	5	7	1	5	77175	4.8333	0.03508
Impermeability of Text	5	7	5	5	3	1/5	1	3937.5	3.1866	0.02026
								Sum:	11.7927	1

*Interpretation of Table 1:*

The Analytic Hierarchy Process (AHP) results presented in Table 1 provide a structured assessment of the relative importance of physical housing indicators. By systematically comparing each indicator against others through pairwise evaluations, AHP translates expert judgments into quantifiable weights, reducing subjectivity and enhancing transparency. This structured weighting not only highlights which physical characteristics most significantly influence overall housing quality but also enables a consistent, replicable framework for integrating diverse attributes into the composite Housing Physical Condition (HPC) index, ensuring that the index accurately reflects real-world priorities and conditions.

- *Pairwise Comparisons:* Each entry in the pairwise comparison matrix represents a quantified judgment of the relative importance of one indicator compared to another, based on Saaty's 1–9 scale. On this scale, a value of 1 indicates that the two indicators are of equal importance, while a value of 9 signifies that one indicator is of extreme importance relative to the other. This structured approach allows for a systematic and transparent assessment of the relative weights of different housing quality indicators, ensuring that the final prioritization reflects expert judgment in a consistent and reproducible manner. For example, in the present analysis, structural stability was evaluated as being seven times more important than building area. This assessment highlights the critical role of structural integrity in maintaining safe and resilient housing, particularly within Tehran's seismic context, where the risk of earthquakes renders stability a paramount concern. Such weight assignments emphasize that while spatial attributes like area are important for livability and comfort, they cannot substitute for fundamental safety considerations. By explicitly incorporating expert judgments into the matrix, the

methodology ensures that both safety and functional aspects of housing are appropriately balanced in the overall Housing Physical Condition (HPC) index.

- *Row Multiplication and Numerical Average:* The row multiplication values represent the product of pairwise comparison scores across each indicator, serving as the initial step in the process of determining their relative weights. These values are subsequently normalized using the numerical average of each row, a procedure that forms the basis for deriving the relative importance coefficients of the indicators. Normalization ensures that each indicator can be compared proportionally with others, reflecting its balanced contribution to the overall index. Crucially, the final importance coefficients are standardized so that their sum equals one. This standardization serves two key purposes: first, it guarantees the relative comparability among indicators, and second, it ensures a balanced integration of weights when calculating the Housing Physical Condition (HPC) index. In other words, this process allows each indicator to contribute proportionally according to its relative significance, resulting in a final index that provides an accurate and reliable representation of the physical quality of housing units.
- *Indicator Weights:* The analysis indicates that among the seven physical indicators, building area carries the highest weight (0.40984), highlighting its critical role in capturing the spatial adequacy and overall livability of housing units. Following this, the number of floors (0.27021) and building height (0.12981) emerge as important contributors, reflecting their influence on residential density, vertical development patterns, and urban form. In contrast, structural stability (0.03508) and impermeability of materials (0.02026) are assigned lower weights, indicating that while they play a relatively smaller role in the overall assessment, they remain essential factors in ensuring safe and functional housing. This weighted hierarchy underscores the multidimensional nature of housing quality, where spatial attributes and vertical configuration dominate the evaluation, yet structural integrity and material performance provide indispensable support to sustain long-term livability and safety standards. By integrating these weights, the HPC index achieves a nuanced and theoretically grounded representation of housing conditions across the study area.

Overall, these findings demonstrate that while spatial capacity and vertical configuration exert the strongest influence on housing quality in District 2, safety- and durability-related factors, though assigned lower weights, remain indispensable given Tehran’s seismic vulnerability, ensuring structural integrity, protecting residents, and reducing potential economic losses.

#### IV. B. 3) Aggregation into the HPC Index

The AHP-derived weights ensured that the Housing Physical Condition (HPC) index accurately captured the relative importance of each indicator, thereby providing a robust and theoretically grounded measure of housing quality that can reliably inform spatial analyses, guide evidence-based policy decisions, and support targeted urban planning interventions aimed at improving residential environments. To construct the index, the seven physical indicators were aggregated using a weighted linear combination. For each statistical area:

$$HPC_i = \sum_{j=1}^7 w_j \cdot X_{ij},$$

where  $w_j$  denotes the normalized weight assigned to indicator  $j$  (as reported in Table 1), reflecting its relative importance in determining overall housing quality, and  $X_{ij}$  represents the standardized value of indicator  $j$  for area  $i$  ensuring comparability across indicators measured on different scales.

Because the indicators were measured on heterogeneous scales (e.g., *building area* in square meters vs. *number of floors* as a discrete count), all raw values were standardized prior to aggregation. Standardization was performed by transforming the raw data into z-scores, calculated using the mean and standard deviation of each indicator across all statistical areas. This procedure ensured comparability and prevented scale-related distortions in the weighted combination.

The resulting HPC scores were subsequently classified into five qualitative categories—*very good*, *good*, *average*, *poor*, and *very poor*—to facilitate interpretation and spatial visualization. Classification was performed using the natural breaks method applied to the distribution of HPC scores, allowing the definition of statistically meaningful thresholds that capture the inherent variability and underlying patterns within the data, thereby improving the interpretability of the resulting classes (Figure 3).

Figures 4 illustrates the spatial distribution of Housing Physical Condition (HPC) categories across District 2. The results reveal a distinct north–south gradient, with northern areas generally exhibiting more favorable housing conditions, while southern areas display comparatively weaker physical quality. This spatial pattern may reflect historical differences in urban development, disparities in access to infrastructure and services, or planning policies that have favored higher-quality housing in the northern part of the district.

Furthermore, five statistical areas within the central belt, dominated by Pardisan Park, were excluded from the analysis due to the absence of significant residential structures. This ensures that the HPC index reflects only inhabited zones, avoiding distortions from non-residential spaces such as parks or institutional land uses, providing a more accurate measure of residential

quality and clearer insights into the relationship between socio-economic factors and housing conditions across District 2 (Figure 4).

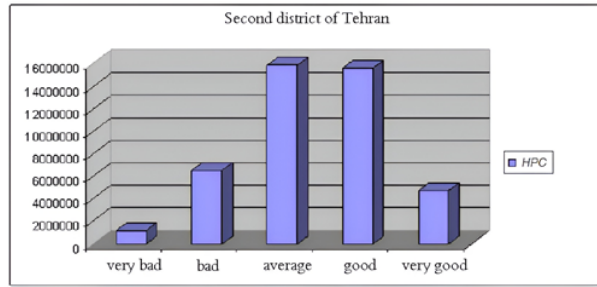


Figure 3: The HPC indicator in the 2nd district of Tehran.



Figure 4: Distribution of the indicator of Housing Physical Condition in the 2nd district.

#### IV. B. 4) Validation and Robustness

To ensure the robustness and credibility of the Housing Physical Condition (HPC) index, a series of sensitivity analyses were conducted to evaluate how variations in indicator weights might affect the stability and reliability of the index. Specifically, alternative weighting scenarios, such as assigning equal weights to all indicators, were tested and compared with the AHP-derived weights. The results demonstrated that, despite these variations, the spatial distribution patterns of the HPC remained largely consistent, confirming that the AHP-based weighting scheme accurately captures the relative importance of each indicator and provides a stable representation of housing quality. This consistency underscores the methodological rigor of the approach and supports the validity of the resulting index for both analytical and policy-making purposes.

In addition to sensitivity testing, rigorous data quality checks were performed to ensure the reliability and accuracy of the underlying datasets. This included cross-validation with field survey data and independent assessments by professional consultants, ensuring that inconsistencies were identified and corrected, thereby enhancing the robustness and credibility of the Housing Physical Condition (HPC) index. [21], [22].

These measures minimized potential errors arising from outdated or incomplete information and reinforced confidence that the HPC index accurately reflects real-world conditions. Collectively, the combination of sensitivity analysis and comprehensive data validation establishes the HPC index as a robust, reliable, and theoretically grounded tool for evaluating residential physical conditions across the study area.

#### IV. C. Analysis of Socio-Economic Impacts on Housing Physical Condition

The relationships between socio-economic indicators and the Housing Physical Condition (HPC) index were systematically examined using Pearson correlation analysis within the SPSS software environment, providing a rigorous and replicable statistical framework to quantify both the strength and direction of associations; this approach enables a precise evaluation of how diverse social and economic factors—such as income, population density, and education—interact to influence housing quality, moving beyond simple descriptive measures to reveal complex patterns and interdependencies between socio-economic conditions and the physical characteristics of residential environments.

A comprehensive set of social and economic variables was incorporated to capture the multidimensional factors shaping residential environments, ensuring a holistic understanding of influences on housing quality. Social indicators included population density, literacy rate, number of families per dwelling, and distances to educational and medical facilities, all chosen for their ability to reflect demographic structure, social capital, and access to essential services. These variables not only indicate residents' immediate living conditions but also have broader implications for housing functionality and comfort—for instance, higher literacy rates may enhance awareness and capacity for home maintenance, while closer proximity to schools and healthcare centers can improve the overall livability and practical suitability of housing for families.

Economic indicators encompassed the share of housing expenditure in total family income, the share of housing expenditure in overall family outgo, and annual housing price inflation, capturing the financial pressures that households face in maintaining or improving their homes. These measures highlight how affordability constraints and broader market dynamics directly influence housing quality, affecting both the ability to invest in repairs and the accessibility of adequate living spaces. By integrating these economic factors with social variables, the analysis provides a comprehensive perspective on the interplay between material resources and socio-demographic conditions, allowing for a more nuanced understanding of the determinants of residential environments and the challenges low- and middle-income households encounter in sustaining housing quality.

All variables were selected based on their theoretical relevance to housing dynamics and their availability from authoritative sources, including the 2016 National Census and municipal surveys conducted by the Statistical Centre of Iran (2016). By integrating social and economic dimensions within a statistically rigorous framework, the study enables a more comprehensive and holistic understanding of how these factors interact with the physical state of housing, providing policymakers and urban planners with actionable evidence and highlighting that meaningful improvements in housing quality require addressing both structural conditions and the broader socio-economic environment that shapes residents' capacity to maintain, adapt, and enhance their homes. The table below shows the correlation coefficients between socio-economic indicators and HPC (Table 2).

The analysis revealed significant correlations between the HPC index and several socio-economic indicators. The number of housing units exhibited the strongest negative correlation ( $r = -0.411$ ,  $p < 0.01$ ), indicating that areas with more housing units tend to have poorer physical conditions, likely due to overcrowding and resource strain. The share of housing expenditure in family outgo ( $r = -0.359$ ,  $p < 0.01$ ) and income ( $r = -0.297$ ,  $p < 0.01$ ) also showed strong negative correlations, suggesting that higher housing cost burdens are associated with lower-quality housing, reflecting economic pressures on households. The statistical area's population ( $r = -0.311$ ,  $p < 0.01$ ) further indicated that higher population densities correlates with poorer housing conditions, consistent with urban overcrowding dynamics. The literacy rate showed a moderate positive correlation ( $r = 0.254$ ,  $p < 0.05$ ), suggesting that higher educational attainment is associated with better housing quality, possibly due to greater economic opportunities and awareness of housing standards.

Table 2: Correlation coefficients of the socio-economic indicators with Housing Physical Condition

<i>HPC</i>	<i>Correlation Coefficient</i>
Number of families per dwelling	-0.164
Statistic area's population	-0.311**
Distance from the nearest school	0.202
Distance from the nearest medical center	0.018
Share of housing from family's income	-0.297**
Share of housing from family's outgo	-0.359**
Number of people per room	-0.133
Annual Housing fee's inflation	0.192
Number of units	-0.411**
Sex rate	-0.016
Pure population density	-0.154
Percentage of employers	0.096
Percentage of unemployed	-0.106
Percentage of active population	0.080
Percentage of literate people	0.254*

Key: \*\*p < 0.01, \*p < 0.05, ns = not significant

These findings underscore the critical influence of socio-economic factors on housing physical conditions, highlighting the need for integrated urban policies that address population density, housing affordability, and educational disparities. The negative correlations with economic indicators emphasize the importance of alleviating housing cost burdens through targeted subsidies or income-enhancing policies, while the positive correlation with literacy suggests that social investments in education can indirectly improve housing quality. The spatial patterns observed in Figure 3 further illustrate that areas with higher socio-economic disadvantage (e.g., southern zones of District 2) exhibit poorer HPC scores, reinforcing the socio-spatial disparities delineated by the Hemmat Highway.

#### IV. D. Discussion and Policy Implications

The development and application of the Housing Physical Condition (HPC) index provide a robust and systematic framework for understanding how socio-economic factors influence the physical quality of housing in District 2. The detailed presentation of the selected indicators, as outlined above, directly addresses concerns regarding insufficient analytical depth by clearly defining each indicator, providing a theoretical and empirical rationale for its inclusion, and specifying the methodology used for its measurement. This comprehensive approach ensures that each component of the HPC index is conceptually grounded and empirically justifiable.

The application of the Analytic Hierarchy Process (AHP) for weighting, as illustrated in Table 1, further strengthens the methodological rigor of the study. By incorporating expert judgment into the weighting process, the HPC index reflects both methodological soundness and consensus on the relative importance of indicators, thereby enhancing the overall credibility and reliability of the results.

The significant correlations identified in Table 2 highlight the multidimensional nature of housing quality, consistent with prior research emphasizing the interdependence of social and economic factors in shaping urban housing outcomes [12], [26]. Specifically, the findings suggest that urban planning and policy interventions in District 2 should focus on alleviating housing cost burdens and effectively managing population density to improve physical housing conditions. Moreover, the observed positive correlation with literacy rates underscores the critical role of social capital in supporting better housing outcomes, indicating that investments in education and community empowerment can produce long-term improvements in housing quality.

In conclusion, this study offers a comprehensive and replicable methodology for evaluating housing physical conditions in relation to socio-economic drivers. By providing detailed insights into the selected indicators and their weighted contributions—as visualized in Table 1 and Figures 3 and 4—the study equips policymakers and urban planners with evidence-based tools to address housing disparities in Tehran's District 2. Ultimately, the research contributes to more equitable and sustainable urban development by linking improvements in housing quality with broader social and economic advancement.

##### *Contribution to Urban Studies and Housing Research*

To address the editorial board's concern regarding insufficient discussion of the study's contribution to the wider research field, this study makes several significant contributions to urban studies and housing research. First, it addresses a critical gap in the literature by providing a district-specific analysis of the interplay between socio-economic factors and physical housing indicators in Tehran's District 2. While prior studies have often focused on macro-level housing policies or economic determinants at the metropolitan scale [20], this research offers a micro-level perspective, examining localized dynamics within a socio-economically diverse urban district. This granular approach enhances the understanding of how socio-economic factors shape physical housing outcomes in specific urban contexts.

Second, by integrating social dimensions—such as household composition, education levels, and cultural practices—with economic variables, this study advances a holistic framework that transcends traditional, physically oriented housing analyses.

This multidimensional approach responds to the need for integrated models that capture the complex interplay of social and economic drivers in shaping housing conditions, offering a more comprehensive perspective than economically focused studies prevalent in the literature [12].

Third, the study contributes to global discourses on sustainable urbanization by providing insights into housing inequalities in a megacity of the Global South. The findings from District 2, with its pronounced socio-spatial disparities, are relevant to other rapidly urbanizing regions facing similar challenges [27], such as Mumbai, Lagos, or Jakarta. By situating housing within broader socio-spatial and economic frameworks, this research aligns with international priorities for equitable urban development, offering comparative insights for scholars and policymakers.

Finally, the proposed conceptual and analytical framework, which employs factor analysis and regression modelling to examine housing as an integrated and dynamic system, provides a replicable methodology for studying urban housing in diverse contexts. By emphasizing spatial equity and socio-economic resilience, this study equips policymakers with evidence-based tools to formulate inclusive housing policies that promote sustainable urban futures. These contributions enhance the study's relevance to urban studies, housing policy, and sustainable development, positioning it as a valuable addition to the literature on urbanization in developing economies.

## V. Conclusion

This study demonstrates that the physical condition of housing is significantly shaped by a range of social and economic factors, highlighting the multidimensional nature of residential quality. To investigate these relationships, the "Housing Physical Condition" (HPC) indicator was first defined, providing a systematic measure of housing quality across the study area. Subsequently, its associations with various social and economic indicators were analysed to identify the key determinants of housing conditions.

The results indicate that among the examined factors, the "Number of units," "Share of housing in family expenditures," "Population of the statistical area," "Share of housing in family income," and "Literacy rate" exhibit the strongest correlations with the HPC index, with each factor contributing differently to housing quality. These findings suggest that both demographic and economic dimensions are crucial in shaping the physical condition of housing, and that interventions focused solely on structural improvements may not suffice to achieve substantial enhancements in residential quality.

Based on these insights, improving the physical condition of housing requires a dual approach that addresses not only structural aspects but also the broader socio-economic environment. Enhancing social indicators—such as increasing the number of available housing units, managing population density, and improving education levels—together with economic strategies, including reducing the proportion of household income allocated to housing through cost reduction or income enhancement, can collectively contribute to better housing quality. Such an integrated approach ensures that physical improvements are sustainable and aligned with the broader well-being of urban residents.

As an original contribution, this study proposes a methodological framework to identify, analyse, and interpret multiple dimensions of housing development and their interrelationships. Drawing on a case study of Tehran's 2nd district, the analysis emphasizes that housing development extends beyond mere physical upgrades and requires a comprehensive understanding of the underlying social processes and economic structures within urban environments. The observed correlations between housing physical conditions and socio-economic indicators reinforce the notion that advancing the quality of housing is intrinsically linked to promoting social and economic well-being, highlighting the importance of integrated planning strategies that address both the material and societal dimensions of urban life.

## Data Sharing Agreement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

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