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Pre and Post-Development Concerns of High–Rise Housing Density Revisited

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Abstract: The demand for high-rise housing in Malaysia continues to rise, driven by urbanisation and land scarcity. While high-rise developments address spatial constraints, they present challenges related to environmental sustainability, social dynamics, and urban quality of life. This study aims to analyse high-rise housing density within the Malaysian context, focusing on pre-development and post-development stages and evaluating the planning methodologies employed by local authorities. A qualitative research approach was employed, integrating a Systematic Literature Review (SLR) and Thematic Analysis. Data mining techniques using Keywords in Context (KWIC) identified critical themes, and qualitative analysis software (Atlas.ti.8) was used to process 150 datasets, including journal articles, policy documents, and government reports. The research refined these datasets through thematic coding into 30 core references that underpin the findings. The study reveals significant inconsistencies in how density standards are applied, often resulting in environmental degradation, social challenges, and infrastructure strain. While Malaysian planning authorities rely heavily on gross and net density metrics, comparisons with international benchmarks, such as those in Singapore and Japan, highlight the potential for integrating advanced digital tools and alternative density measures to enhance planning outcomes. Future research should explore the application of Geographic Information Systems (GIS) and Building Information Modelling (BIM) to improve density planning. Additionally, long-term studies on Transit-Oriented Development (TOD) initiatives and strategies for retrofitting high-density developments to enhance liveability and sustainability are recommended. This study advances understanding by offering a nuanced framework for addressing high-rise housing density and its implications for sustainable urban growth.

Keywords: Density, housing, Malaysia, sustainability, urbanisation.

Introduction

Housing significantly influences quality of life, serving as a fundamental necessity alongside food and health (Awad, 2012). It encompasses psychological, social, economic, and physical dimensions, with quality determined by economic, social, political, and environmental factors. Housing preferences vary, encompassing size, location, facilities, and affordability. Population density, often linked to housing demand, reflects the distribution of people across an area, influenced by factors like politics, climate, and time (Forsyth, 2003). Density, as understood in urban planning, involves measures of space utilisation, patterns, and intensity. It also encompasses behavioural dimensions, such as perceptions of overcrowding and congestion (Boyko & Cooper, 2011). Housing density is a critical element of land-use management. Measurements, including floor space, plot ratios, and dwellings per hectare, are applied during the planning phase to ensure project feasibility (CIDB, 2019). Keeble (1969) historically observed the absence of unified density control methods, often associating density with negatives like congestion and pollution (Yakob et al., 2012). Urban density assessments occur at macro (urban) and micro (building) levels, with sustainability shaping the distinctive characteristics of cities (Wahi et al., 2018). In Malaysia, urban housing faces challenges tied to population growth and increased service demand. Congestion, pollution, and security concerns impact community well-being, highlighting the psychological strain of urban living (Tripathi & Rani, 2017). The "Compact City" concept attempts to balance urban efficiency with liveability but faces obstacles like insufficient green spaces and traffic congestion (Chan, 2002). Local Plans (LPs) under Act 172 guide land-use, translating strategic policies into practical development frameworks (JPBD, 2016). Density definitions under Act 172 emphasise ratios like units per acre or gross density for broader areas, incorporating infrastructure and vacant lands. In contrast, net density focuses on specific land-use zoning (Marzukhi, 2023). These measures aim to enhance urban functionality but face challenges like noise, pollution, and the loss of green spaces (Tessem et al., 2015). This paper reviews the recurring challenges of high-rise housing density in

Malaysia and internationally, linking insights to future urban planning strategies.

Literature Review

The sections underscore the complexity of housing density as a planning and social issue. While high-rise developments address land scarcity, their success depends on consistent planning guidelines, comprehensive measurement methodologies, and policies prioritising liveability and community well-being. Addressing these gaps will require collaboration between planners, policymakers, and researchers to develop more holistic and sustainable approaches to urban housing. Housing density, a crucial element of urban planning, reflects land-use intensity in residential developments. Globally, urbanisation has led to a significant increase in housing demand, particularly in areas with limited land (Awad, 2012). The transition from horizontal to vertical developments, often called high-rise housing, is a solution to land scarcity but comes with challenges related to environmental sustainability, social dynamics, and urban quality of life (Aziz et al., 2014). Like many developing nations, Malaysia faces these issues acutely, as urban sprawl and population growth amplify the need for housing solutions that balance density and liveability (Department of Statistics Malaysia, 2010). High-rise housing developments are often challenged during pre-development, particularly in aligning proposed densities with existing infrastructure and community needs. For instance, inconsistencies in local planning guidelines can lead to disputes over the appropriateness of proposed projects (Mohd et al., 2007). The Construction Industry Standard (CIS 26:2019) emphasises creating accessible and equitable housing to improve quality of life while considering environmental and social impacts (CIDB, 2019). However, evidence suggests that local authorities frequently deviate from these standards, resulting in varied interpretations of housing density across different regions (Yakob et al., 2012). The impact of pre-development density decisions extends to issues such as inadequate infrastructure, environmental degradation, and community pushback. In Taman Tiara Titiwangsa, Malaysia, residents opposed projects that significantly increased population density, citing concerns over traffic congestion and insufficient infrastructure (Ahmad et al., 2007).

Post-development challenges often manifest as quality of life concerns, particularly in densely populated urban areas. High-rise developments have been associated with social isolation, increased crime rates, and reduced access to public amenities (Wahi et al., 2018). The concept of "Compact City," while promoting shorter commutes and reduced environmental footprints, often exacerbates issues like overcrowding and loss of green spaces (Tripathi & Rani, 2017). Moreover, disparities in housing quality between low-cost and high-cost developments contribute to socio-economic divides. Research highlights that residents in low-cost, high-rise buildings often face poor maintenance, limited safety measures, and inadequate communal facilities (Wahi et al., 2018). These conditions underscore the need for comprehensive policies that address the broader social implications of high-density living.

The measurement of housing density is critical for effective urban planning. Terms like "gross density," "net density," and "population density" are frequently used but often inconsistently defined, leading to confusion in planning practices (Boyko & Cooper, 2011). Gross density typically includes all land within a development, while net density focuses on the residential area, excluding public amenities and infrastructure (Forsyth, 2003). However, Malaysia's absence of standardised methodologies for measuring density creates significant variability in planning outcomes (CIDB, 2019). Accessible density, as proposed by Berghauser and Haupt (2003), provides a more precise framework for understanding the relationship between density and urban form. This approach considers numerical measures and the qualitative aspects of density, such as accessibility to amenities and integration with the surrounding environment. This study fills critical gaps in the literature by providing a comprehensive analysis of high-rise housing density in Malaysia. It addresses standardisation, sustainability, policy enforcement, social dimensions, infrastructure challenges, and global adaptability, offering a robust framework for urban planning that bridges existing knowledge gaps while contributing to the broader discourse on sustainable urban development.

The literature highlights several critical gaps in understanding and managing housing density in urban contexts, particularly in high-rise developments. One significant issue is the lack of standardised definitions and frameworks for density, which creates inconsistencies in urban planning and policy implementation (Awad, 2012; Boyko & Cooper, 2011). Without a clear and unified approach to measuring and defining density, planning efforts risk being fragmented and misaligned with broader urban development goals. This paper addresses this gap by analysing existing policies in Malaysia and proposing recommendations to standardise density frameworks. Another recurring theme in the literature is the inadequate integration of sustainability into planning, especially in high-density urban areas (Aziz et al., 2014; Marzukhi, 2023). Previous studies have emphasised the need for environmentally sustainable and energy-efficient strategies for high-rise housing but have found limited success in their application. This paper

contributes to the discussion by exploring Malaysia-specific strategies for incorporating sustainability into high-rise developments, offering practical solutions to bridge this gap.

Policy variability and enforcement inconsistencies further exacerbate the challenges of urban housing density.

Table 1. Comprehensive literature analysis.

Author(s) & Year	Focus Area	Identified Gaps
Awad, 2012	Conceptualisation of housing density and urban planning	Need for standardised definitions and frameworks for density
Aziz et al., 2014	Vertical Living and Its socio-environmental Implications in Malaysia	Limited integration of environmental impacts into planning guidelines
Department of Statistics Malaysia, 2010	Statistical overview of population and urban density in Malaysia	Lack of actionable insights for urban policy applications
Mohd et al., 2007	Challenges in urban housing planning and policy inconsistencies	Variability in local implementation of housing density standards
CIDB, 2019	National standards for equitable and accessible housing	Implementation gaps in achieving equitable housing standards
Yakob et al., 2012	Land-use regulations and planning practices in Malaysia	Lack of consistency in land-use planning practices
Wahi et al., 2018	Social issues in low-cost, high-rise housing developments	Inadequate attention to maintenance and safety in high-rise housing
Tripathi & Rani, 2017	Environmental and social consequences of urbanisation	The under-researched link between density and sustainability
Boyko & Cooper, 2011	Clarifying and re-conceptualising density in urban planning	Insufficient focus on qualitative dimensions of density
Berghauser & Haupt, 2003	Accessible density as a framework for urban form	Overlooked potential of integrated density frameworks
Forsyth, 2003	Measurement methodologies for residential density	Need for alignment between measurement methods and planning goals
Marzukhi, 2023	Sustainable high-rise development strategies in Malaysia	Limited research on integrating sustainability in urban high-rise planning
Wahi, 2018	Issues and Challenges of low-cost housing in high-rise settings	Neglect of maintenance and community engagement in low-cost housing
Husin et al., 2021	A Systematic Review of density challenges in urban residential projects	Lack of unified Criteria for density measurement in Malaysia
Habitat Magazine, 2020	Global housing density challenges and innovative solutions	Need for adaptive solutions addressing urban density in diverse contexts
Chan, 2002	Historical perspectives on housing density and urban planning in Hong Kong	Historical insights not fully leveraged for modern urban planning
Adeyemi et al., 2024	Architectural strategies for high-density affordable housing	Integration of functionality and space optimisation in high-rise housing
Dwijendra et al., 2021	Social impacts of high-rise residential buildings	Assessment of post-occupancy well-being impacts
Rahmawati et al., 2020	Environmental enhancement through building refurbishment	Sustainability enhancement for existing urban structures
Kurvinen & Saari, 2020	Urban housing density and infrastructure costs	Cost implications of density for urban infrastructure
Li et al., 2023	Nature exposure analytics for high-rise urban planning	Balancing urban nature exposure in high-rise cities

Mohd et al. (2007) and CIDB (2019) identified discrepancies in how local authorities implement housing density standards, leading to uneven urban development. By examining these policy inconsistencies in the Malaysian context, this study provides insights into how enforcement mechanisms can be improved to achieve equitable and accessible housing. Social dimensions, such as community engagement and post-occupancy well-being, are also underexplored in high-density housing. Research by Wahi et al. (2018) and Dwijendra et al. (2021) highlighted issues such as inadequate maintenance and safety measures and neglecting residents' well-being in post-occupancy evaluations. This paper addresses these concerns by emphasising the importance of community engagement and the social implications of high-rise housing, aiming to foster more inclusive and liveable urban environments. Infrastructure challenges and the need for adaptability in urban planning are additional gaps identified in the literature. Kurvinen and Saari (2020) and Li et al. (2023) underscored the difficulties of maintaining infrastructure to support high-density living and balancing urban nature exposure in high-rise cities. This study discusses strategies to address these challenges, ensuring infrastructure and urban design support density and liveability. The literature reveals a lack of historical and global perspectives integration into modern urban planning. Studies by Chan (2002) and Habitat Magazine (2020) highlighted the potential benefits of leveraging historical insights and global innovations to address contemporary urban density challenges. This paper integrates these perspectives, contextualising global solutions within the unique challenges faced by Malaysia.

Materials and Methods

This study employs a qualitative research paradigm, integrating a SLR method and Thematic Analysis. The research began by generating raw data pools through data mining procedures using Keywords in Context (KWIC) (Luhn, 1966). KWIC facilitated the identification of key "leads," which were expanded through "Snowball Techniques" (Wohlin, 2014). Boolean operators were used to search online data archives, printed publications, and online-based repositories. This comprehensive search process gathered 150 data sets, comprising production data, research journals, annual reports, newspaper and magazine articles, and periodicals. From an initial pool of 150 data sources, the refinement process employed inclusion criteria prioritising relevance to Malaysia, recency (2008–2023), methodological rigour, and focus on high-rise housing. Seminal works predating this range were retained for foundational insights (Luhn, 1966; Wohlin, 2014). Exclusion criteria eliminated studies on non-residential metrics, duplicative works, and those with inadequate methodologies. The final selection aligned with three themes: challenges in high-rise housing density during pre-development stages, issues during development and post-development, and methods for determining and measuring density. The raw data collected was analysed using qualitative analysis software Atlas.ti.8, allowing for the detection of recurring word patterns through "Word Cloud Techniques" (Tessem et al., 2015). Specific phrases such as "Density," "High-Rise", "Urban Density", "Planning Approval" and "Population" were identified as recurring themes. A total of 11,875 terms from 83 sources were processed, with the term "density" referenced 1,187 times in materials containing the term "urban." This underscores the relevance of density as a critical topic in existing research, aligning with the study's objectives. Thematic Analysis narrowed the data pool to 30 key works of literature, which served as the primary references. These references formed the basis of the emergent themes presented in this study:

(1) Challenges in high-rise housing density during pre-development stages.
(2) Issues commonly associated with high-rise housing density.
(3) Approaches to determining high-rise housing density.

These themes guided the narrative structure of this research, addressing three key research questions:

(1) What are the challenges associated with high-rise housing density during the pre-development stages?
(2) What issues are frequently associated with high-rise housing density during development and post-development?
(3) How is high-rise housing density determined and measured?

Gross density and net density metrics were employed to evaluate housing density, offering complementary perspectives. Gross density, defined as the total number of housing units per unit area inclusive of all land uses, provided macro-level insights, while net density, focusing on residential areas, captured micro-level nuances (Forsyth, 2003; Berghauser & Haupt, 2003). The integration of these metrics was further refined by advanced techniques drawn from recent studies, including environmental quality assessments (Song et al., 2021) and resilience-based frameworks (Wei et al., 2023).

The Word Cloud analysis (Fig. 1) provided quantitative insight into frequency of key terms within the data pool.

- The term "density" appeared prominently, reflecting its significance in prior research.
- Related terms such as "growth" and "urban" were also frequently cited,

highlighting their interconnectedness with housing density.

- This analysis underscores the critical need for Malaysia to expand its research focus on high-rise housing density, as current studies remain insufficient.

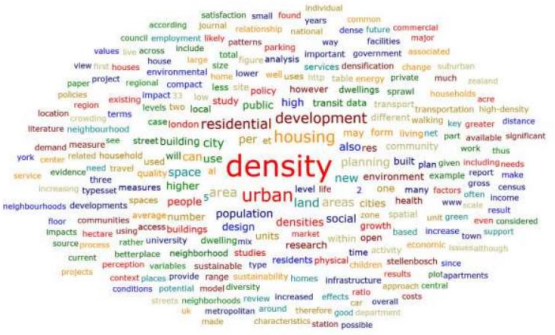

Fig. 1 Word cloud analysis of relevant literature in the data pool.

The suggested approach strengthens the study's methodology by combining qualitative and quantitative analyses, thematic coding, and advanced metrics. Using SLR ensures a rigorous synthesis of existing knowledge, while Thematic Analysis identifies gaps and emergent themes, setting a robust foundation for addressing the research questions. Additionally, Atlas.ti.8 enhances transparency and replicability, aligning this study with best practices in urban density research.

Results and Discussion

High-rise housing density presents challenges and opportunities, with its impacts extending across urban planning, social dynamics, and environmental sustainability. This study contextualises density within Malaysia's urban landscape to bridge theoretical insights with practical applications while drawing lessons from global benchmarks. For instance, while Malaysia often emphasises gross density metrics to ensure policy compliance, international practices such as those in Singapore and Hong Kong prioritise integrated approaches that balance gross and net density alongside metrics for liveability and sustainability (Li et al., 2023). Incorporating these global insights, Malaysian urban planning can transition from policy-focused density assessments to a more holistic approach that addresses community well-being and environmental concerns. Density and housing density concentration are strategic priority methods for regulating the living standards, requirements, and expectations of the inhabited space. A planner may also design the spatial configuration of buildings, the route, and the provision of access (Awad, 2012). Boyko and Cooper (2011) also support that developing effective housing density policies, particularly for multi-storey housing, is essential. This includes three essential considerations: flexibility, versatility, and an understanding of soft-density and hard-density elements (Boyko & Cooper, 2011).

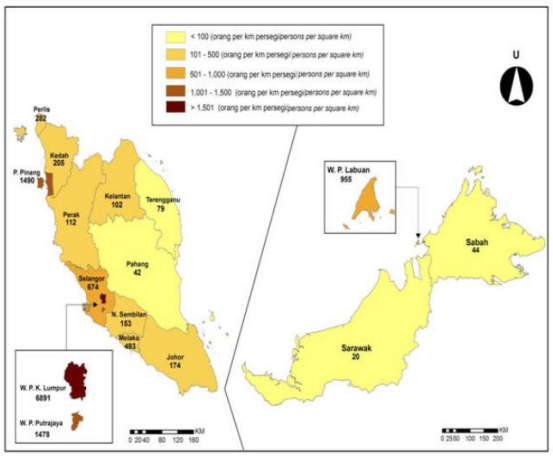

Fig. 2 Malaysia population density (2010).
(Source: Department of Statistics Malaysia, 2010).

The findings are the subject of a discussion divided into three interconnected themes: i) High-rise housing density during pre-development phases, ii) The issue of high-rise housing post-development, and iii) The determination of high-rise housing density. The population density is frequently correlated with the density of high-rise housing. According to the Malaysia Census (2010), country's population density was 86 persons per square kilometre in 2010, higher than 71 persons per square kilometre in 2000. This represents a 17% increase. The population density was represented in a manner distinct from the population distribution. Selangor, the most populous province, was ranked fifth in population density, with 674 persons per square kilometre. Pulau Pinang (1,490 persons), W. P. Kuala Lumpur (6,891 persons), and W. P. Putrajaya (1,478 persons) were among the most densely populated states. Most of these regions are urban, and the demand for housing is high due to scarcity of land. The presence of high-rise residences characterises these regions. In 2010, the proportion of the urban population increased to 71.0 per cent, while it was 62.0 per cent in 2000, consistent with Malaysia's accelerated development (Fig. 3).

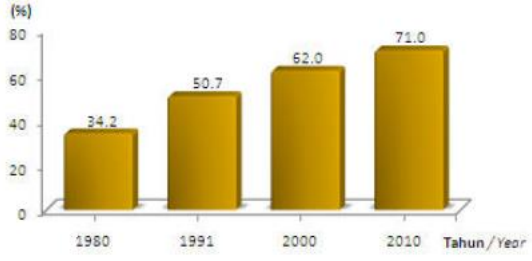

Fig. 3 Urbanisation rate from 1980 to 2010.
(Source: Department of Statistics Malaysia).

In addition to Kuala Lumpur and Putrajaya, which have a 100% urbanisation rate, Selangor and Pulau Pinang have a high level of urbanisation at 91.4% and 90.8%, respectively (Fig. 4). In contrast, Kelantan (42.4%), Pahang (50.5%), and Perlis (51.4%) exhibited lower levels of urbanisation.

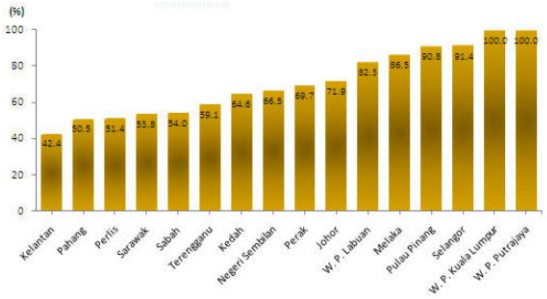

Fig. 4 Urbanisation rate according to states.
(Source: Department of Statistics Malaysia)

High-Rise Housing Density during Pre-Development Stages

High-rise dwellings in Malaysia are categorised into three distinct housing forms: condominiums, flats, and apartments. These housing types offer a variety of amenities. This residential area, classified as low and medium-cost housing, is characterised by its compact size, open parking, and lifts. Additionally, certain areas lack security controls. A surau, covered car parking, leisure area, playgrounds, lifts, security locks and encompassing fences are among the amenities, the multi-storey apartments offer compared to the flats. The amenities provided for multi-storey condominium complexes include a swimming pool, gym, laundromat, elevator, security system, and a fenced perimeter.

In addition to being a significant factor in the production and development of the real estate sector and economic growth on a domestic and international scale, these types of housing complexes are also a significant component of land-use. This sector has changed expectations and paradigms, transitioning from viewing houses as "places of residence" to ensure that the accommodation provided is affordable and adequate for various societal groups. The result will be the necessity to appreciate the environment of the specific housing unit, which is conducive, convenient, standard, healthy, and harmonious.

There are also instances in which the impact of housing density approval is felt prior to the commencement of the development. The consequence occurs when the housing density of the proposed housing project indicated in the LP is either excessively low or excessively high. Quantitative, neutral, and objective, housing density is how does it arrive at a neutral state. This is neutral because the density is not explicitly known to be positive or negative. Aziz et al. (2014) found that the increase in housing density has positive and negative effects when analysing various housing proposals and the increase in housing density is inextricably linked to the average reduction in floor space for each residence, and the increase in floor area. As density increases, there will be an increase in the number of dwellings available. The proposed plan may be subject to the authority's enforcement of numerous conditions or specifics to consider relevant development plans or current planning materials. The plan's modifications regarding infrastructure work, additional facilities development, and density are among the primary matters of contention (Ahmad et al., 2007).

The Construction Industry Standard (CIS 26:2019 – National Housing Standard) restricts housing density to emphasise the development of safe, accessible, and equitable housing, enhancing the quality of life and providing affordable living accommodations for urban areas. Moreover, it will reduce construction development expenses without compromising housing quality, physical infrastructure, or the housing environment (Construction Industry Development Board Malaysia (CIDB), 2019). Housing density is a quantitative indicator of the intensity of land occupied by the community or a development project. Housing density is an empirical intensity measurement method employed in land development. Housing density is a critical practical element of land-use planning in population allocation from the perspectives of regulations and planning. As a result, it impacts public services, including transportation, utilities, and infrastructure in general.

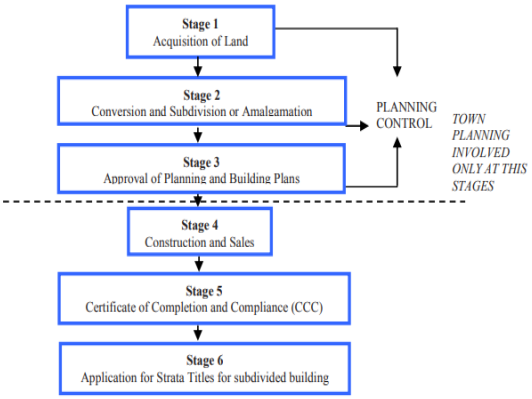

Fig. 5 Flow chart for the housing development process.
Source: Yakob et al. (2012).

The process of developing high-rise housing is illustrated in Figure 5. Stage 3 meticulously delineates the population density and housing density. Before any development is considered, the overall project's suitability will be assessed by local planning authorities (Aziz et al., 2014). The initial

stage of the Planning Permission process also involves the determination of density. Additionally, the policies of the LPs also address density.

Nevertheless, in actuality, each development is evaluated independently, according to the discretion of the individual. These challenges obtain a more accurate measurement of the appropriate density for the specific development. However, the value of the real estate will be impacted if the confusion persists. The planning standards and multi-storey housing are defined with extensive parameters in the Guidelines for Housing Planning (2016) published by the Department of Town and Rural Planning, Peninsular Malaysia (Malay: *Jabatan Perancangan Bandar dan Desa Semenanjung Malaysia* (JPBD).

Table 2. Minimum floor space for high-rise housing.

Type of Multi-storey dwelling	Minimum Floor space per parcel/unit
Low-cost Apartments/Flats	700 sq. ft.
Medium-Low cost apartments	750 sq. ft.
Medium-Cost Apartments	850 sq. ft.
High-cost apartments	1000 sq. ft.
Town House	900 sq. ft.

Source: Department of Town and Country Planning Peninsular Malaysia (JPBD) (2016).

The set parameters for multi-storey housing are restricted to a specific number per acre, in addition to the previously mentioned Table 2. Multi-storey housing within District Councils is restricted to 60 units per acre, while those within the City Council/City Hall are permitted to have 80 units per acre. TOD housing is permitted to have 90 units per acre. However, the perception of allowable net housing density and gross density in development plan policies, particularly in the context of housing densities, is reliant on personal judgements and is becoming increasingly perplexing (Mohd et al., 2007).

The primary concern is the impact of the housing density that the One Stop Centre Committee (OSC) has approved, which is either in compliance with or in violation of local planning and planning guidelines for a density defined in the LP. In certain instances, the effect occurred after the housing project had obtained additional density prior to the Planning Approval (PA) or Development Order (DO) from the original density specified in the LP. Most of the time, the new housing density is established after the construction is complete. So, housing density is one factor associated with the socio-economic status of Malaysians, particularly those who fall into the low-income category, where housing development is denser. The impact, which is significant when compared to those in a higher income bracket, includes inadequate access to social facilities and the prevalence of social problems (Tripathi & Rani, 2017). The implementation of high-density housing is imminent. The widespread belief is that expanding high-rise buildings has exacerbated urban dysfunction and social degradation in residential areas (Aziz et al., 2014). Unfavourable image branding has also negatively impacted high-rise housing in low- and medium-cost housing initiatives. According to research on living satisfaction at these venues, living in dense areas is associated with minimal maintenance, crime, health issues, and safety (Wahi et al., 2018).

Determination of high-rise housing density

Table 3 illustrates the housing density standards for multi-storey housing developments in high-rises. Nevertheless, the density of multi-storey housing is also contingent upon the approved Local Authority (LA) and the proposed LP density of the area. Housing density has historically been determined by the number of residential units, occupied rooms, and available apartments in square meters, particularly in high-rise or multi-storey developments. On a macro scale, the density of the specific surrounding area, a more indicative measurement of housing density, may be compared to the plot ratio of the land and building concerning the building design (Yakob et al., 2012). Malaysia's density standards, typically defined by gross and net density, often lack the nuanced frameworks seen in international counterparts. For instance, Japan incorporates "population density per household unit" to assess urban density's socio-economic impacts, while the Netherlands uses "accessible density" to evaluate public space availability in high-density regions (Berghauser & Haupt, 2003). By adopting similar benchmarks, Malaysia could mitigate the negative perceptions of density by demonstrating its alignment with global best practices and potential to improve urban quality of life.

Table 3. Multi-storey housing standards.

Aspect	Maximum Standard Density
Urban areas in Selangor, Penang, Johor and Kuala Lumpur	120 unit/acre
Within TOD and Transit planning zoning areas (within 400 meters [1312.34 feet] from the main transit station)	150 Units/acre

Note: 1 acre = 0.404686 hectare
Source: (Construction Industry Developtment Board Malaysia (CIDB), 2019).

Table 4. Method of calculating housing density.

No	Method of Calculation	Detail
1	Site Area	On more significant sites for multiple dwellings, the entire site, including areas used for access roads, will contribute to the site area. Smaller sites of any scale can require up to the mid-point in frontage to the street. Measurements ought to be in hectares
2	Number of dwellings per hectare/acre – (use in lower density)	This is the most widely used measurement method, but should only be used for lower density developments as dwellings vary widely in size and accommodation. **Number of Dwellings per Hectare = Number of Dwellings / Site Area (Hectares)**
3	Number of Habitable Rooms per Hectare - (use in medium to high-density)	The amount of habitable housing provides a valuable indicator of the future population and shows land-use density (Habitable rooms are primarily used in Census data). This measure also allows for an estimate of the comparative size of the growth. Only habitable rooms shall be included in the evaluation. **Habitable Rooms per Hectare = Number of Habitable Rooms / Site Area (Hectares)**
4	Plot Ratio / FAR	Generally expressed as a representative fraction, percentage or decimal ratio, i.e. 1/4, 0.25/1, 25%, or 0.25:1. Provides a comparative measure of the volume of building development concerning the site area. The gross floor space of all accommodation (measured from the outside dimension) is used for the measurement, including ancillary accommodation. **Plot Ratio = Gross Floor space / Total Site Area (m)**

Source: adapted from Forsyth (2003), Metropolitan Council (2015) and Woking Borough Council (1999).

Table 5. Method for determining high rise density.

City	Primary Metrics/Methods	Key Features.	Focus Area
Hong Kong	Gross & Net Density, FAR, TOD	High-density development around transit hubs, integration of green spaces, and maximising land-use efficiency.	Sustainability, TOD, Liveability.
Singapore	Gross & Net Density, FAR, Vertical Integration	Strategic zoning with higher FAR near transit hubs; vertical integration of residential, commercial, and recreational spaces.	Optimising limited land, integrated urban living.
New York City	Zoning Regulations, FAR, People-Per-Acre, Shadow Studies	Ensures balance between density and infrastructure; zoning focuses on commercial and transit-heavy areas.	Infrastructure capacity, urban design aesthetics.
Tokyo	Population Density, FAR Adjustments, Setback and Height Controls	FAR incentives for public amenities and green spaces; height and setback controls for liveability.	Efficiency, urban aesthetics, and public amenity integration.
London	Plot Coverage, Residential Units Per Hectare, Height Ratios	Density is linked to the accessibility of public transport, preserving historical sites and mixed-use developments.	Accessibility, historic preservation, mixed-use development.
Toronto	People-per-hectare, Mixed-Use Zoning, Urban Design Guidelines	Focuses on demographic alignment, green space integration, and ensuring urban aesthetics and sunlight access.	Liveability, mixed-use planning, and affordable housing.
Mumbai	FAR Regulations, Vertical Expansion, Population Per Square Kilometre, Public Infrastructure Contributions	Encourages vertical redevelopment incentives for developers to contribute to public infrastructure.	Land optimisation, slum redevelopment, and urban growth.
Malaysia	Gross & Net Density, Units Per Acre, Plot Intensity, Local Plans (LP)	Local zoning regulations: LP guides land-use and determines ratios of housing units or individuals per acre.	Aligning urbanisation with sustainability and social needs.

Source: Berghauser & Haupt (2003), Boyko & Cooper (2011), Construction Industry Development Board Malaysia [CIDB] (2019), Forsyth (2003), Kurvinen & Saari (2020), Li, Xue, & Yeh (2023), Marzukhi (2023), Wahi, Mohamad Zin, Munikanan, Mohamad, & Junaini (2018), (Wong & Chu (2012), Yakob, Yusof, & Hamdan (2012).

The findings reveal that inconsistencies in density standards frequently lead to practical challenges, such as infrastructure strain and social isolation in densely populated high-rise developments. For example, in Kuala Lumpur's city centre, high-rise residential areas often experience severe traffic congestion and inadequate green spaces due to poorly implemented density planning (Marzukhi, 2023). Comparatively, Singapore's Marina Bay Sands development demonstrates how density can be effectively managed through mixed-use zoning, integrated transport networks, and accessible communal spaces, showcasing the potential for density to contribute positively to urban environments.

Boyko and Cooper (2011) examined the concept of density, emphasising the variable used to assess density. Density is not merely a unique quantitative measurement. The housing density is frequently perceived as a component of the urban environment, referred to as "hard" and can be quantified, and "soft," which is quantified qualitatively. Therefore, density measurements must encompass both contextual and elemental components. There has never been a consensus on estimating and determining housing density and clear subjective definitions. Consequently, low, medium, and high-density concepts lack international guidelines (Sivam et al., 2012). Berghauser and Haupt (2003) recommend using "Accessible Density" as a density measurement method due to its more precise direction and action than urban land-use zoning. The subdivision of an existing property into more dwellings is likely inappropriate unless the property is sufficiently large to facilitate the additional parking provision without compromising the character and amenity of the adjacent dwellings. It is generally possible to circumvent significant parking areas in the rear gardens of family residences (Noor et al., 2014). The method of calculating density is subject to change based on the PA authorities. A density standard that is implemented throughout the administrative regions is typically published by planning authorities. In most cases, the density will be adjusted to accommodate an additional housing unit, contingent upon the location and other factors. The following methods can be used to calculate housing density in general (Table 3).

The primary concern when determining housing density is the volume and scope of development. The density assessment will be conducted for planning purposes, considering the number of habitable rooms and dwellings per hectare. Nevertheless, the plot ratio (gross floor area to site area) can also be employed in higher-density urban areas, as each measurement method and its appropriate application has been previously discussed. In order to determine the most suitable parking space, it is imperative to provide information regarding the quantity and type of accommodation. It is also necessary to consider the extent of the site dedicated to hard-surfaced parking areas in subdivided lands, as this could impact the area's character and amenities (Forsyth, 2003). Density inconsistencies manifest in various real-world issues, from infrastructure overload to diminished quality of life. In Malaysian high-rise developments, inconsistent density calculations often result in overcrowding, insufficient parking, and limited green spaces, exacerbating social tensions and reducing urban liveability (Wahi, 2018). These challenges emphasise the need for standardised frameworks that measure density and guide its practical implementation. Lessons from Singapore's Housing and Development Board (HDB) initiatives, which integrate density planning with community-oriented amenities, highlight the transformative potential of cohesive density strategies. Density is often viewed negatively due to its association with overcrowding, noise, and reduced privacy. However, when managed effectively, density can yield significant benefits, such as reduced urban sprawl, improved access to services, and enhanced sustainability. The negative perceptions stem largely from inadequate planning and policy enforcement, which fail to balance density with essential amenities and infrastructure. For example, in Hong Kong, density is celebrated for enabling efficient public transport and compact urban living, but only because it is supported by meticulous urban planning and infrastructure investment (Chan, 2002).

This underscores the importance of shifting the narrative around density in Malaysia, presenting it as a tool for sustainable urban growth rather than a source of urban challenges. High-rise housing density is determined through various global methods, each tailored to specific cities' unique urban needs and challenges. Hong Kong employs gross and net density metrics along with Floor Area Ratio (FAR), focusing on maximising land-use efficiency through TOD and integrating green spaces to enhance sustainability and liveability (Berghauser & Haupt, 2003). Similarly, Singapore utilises gross and net density and plot ratios, but integrates vertical mixed-use developments, combining residential, commercial, and recreational spaces to optimise limited land (Li et al., 2023). In New York City, zoning regulations and FAR are complemented by people-per-acre metrics and shadow studies to balance density with infrastructure capacity and urban aesthetics (Boyko & Cooper, 2011). Tokyo incorporates population density and FAR adjustments with setback and

height controls, offering incentives for public amenities and green spaces, emphasising efficiency and liveability (Forsyth, 2003). On the other hand, London measures density through plot coverage, residential units per hectare, and height ratios, aligning density with public transport accessibility and historical preservation while promoting mixed-use development (Yakob et al., 2012). Toronto combines people-per-hectare metrics with urban design guidelines and mixed-use zoning to maintain urban liveability, ensuring demographic alignment and access to green spaces (Kurvinen & Saari, 2020). In Mumbai, FAR regulations and population density metrics drive vertical redevelopment, with incentives for public infrastructure contributions to optimise land-use and support urban growth (Wahi et al., 2018). Lastly, Malaysia adopts gross and net density metrics, units per acre, and plot intensity guided by Local Plans (LP), ensuring alignment of urbanisation with sustainability and social needs (Marzukhi, 2023; CIDB, 2019).

Conclusion

The density of proposed development is one of several factors in determining the suitability of high-rise housing projects. As noted in the literature, density alone cannot define a project's success; aspects such as layout, spacing, and preservation of environmental features are equally crucial. This study highlights the need for a multi-faceted approach that integrates environmental, social, and economic considerations. Density application inconsistencies often lead to infrastructure strain, environmental degradation, and socio-economic disparities. While higher densities near transit hubs or town centres may be justified, their broader impacts must be carefully managed to ensure positive outcomes for urban functionality. Malaysia's density planning lacks the nuanced frameworks in Singapore's mixed-use developments and Japan's population density metrics. Incorporating measures like accessible density can better align local strategies with global benchmarks, improving liveability and reducing socio-environmental challenges.

However, local implementation of standards like CIS 26:2019 often falls short due to inconsistent application of metrics. This study reinforces the importance of advanced tools such as GIS and BIM to enhance precision in density planning and scenario simulations. For example, Singapore's Marina Bay Sands demonstrates how mixed-use zoning and integrated networks can make high-density developments sustainable and efficient. Retrofitting existing projects with energy-efficient designs, green spaces, and community amenities offers another path forward.

Planning authorities must assess developments beyond density metrics, considering broader implications for infrastructure, sustainability, and community dynamics. Frameworks like accessible density can mitigate overcrowding and isolation (Song et al., 2021). Future research should explore GIS and BIM integration to address Malaysia's urban challenges, study TOD initiatives' impacts on affordability and mobility (Peng & Maing, 2021), and analyse cultural perceptions of density (Chan, 2002). By aligning planning methodologies with global best practices, Malaysia can redefine density as an equitable and sustainable urban growth tool.

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