



SATURATION DEVELOPMENT PATTERN OF BUILT-UP AREAS IN KUALA LUMPUR CITY CENTER

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Abstract

Kuala Lumpur, designated a city in 1972 and a Federal Territory in 1974, has undergone rapid urbanisation, significantly impacting its infrastructure and environmental systems. With a population exceeding 1.9 million by 2022 within 242.7 square kilometres, the city's land area has expanded to 2,584.11 hectares, reflecting intense development pressures and increased land densification. This study presents a comprehensive analysis of the spatio-temporal dynamics of urban development within the Kuala Lumpur City Centre (KLCC) between 2015 and 2023. The primary objective is to evaluate the intensity and saturation of development patterns within a one-kilometre radius of the Petronas Twin Towers and to investigate the correlation between these patterns and existing development control instruments. A mixed methodology is employed, integrating qualitative field observations with quantitative analysis of satellite imagery through advanced image processing and Geographic Information System (GIS) techniques. Situated within the context of the KLCP 2040's land use targets and the high-intensity zoning of the "City Centre" (plot ratio 4:1 to 10:1). The results indicate that built-up areas increased significantly between 2015 and 2023, with Bukit Bintang recording the highest saturation level. Development intensity was strongly associated with zoning regulations, plot ratio controls, and high-rise mixed-use developments within the KLCP2040 framework. The findings provide evidence to support sustainable development control and urban growth management within Kuala Lumpur City Centre.

Keywords: Built-up Area, Development Intensity, Saturated Development, Remote Sensing

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INTRODUCTION

Urbanisation in Malaysia is a multifaceted phenomenon, propelled by demographic factors such as natural population growth and net migration, alongside administrative mechanisms like the annexation and reclassification of rural territories (Cohen, 2004; Todd et al., 2019). This has resulted in a disproportionately rapid expansion of the urban populace, leading metropolitan centres to extend beyond their gazetted limits and exhibit increased development density (Grunsvén & Benson, 2020). The area surrounding Kuala Lumpur City Centre (KLCC) exemplifies the challenges of this rapid expansion. Central urban zones are approaching a state of saturation, where infrastructural and land resources are fully utilised, compelling development to spill over into peripheral rural areas (Hasan & Nair, 2014; Tey & Lai, 2022). Monitoring this saturation growth is therefore essential for sustainable urban management. To regulate this expansion, authorities employ development control instruments such as zoning laws and density regulations (Boori et al., 2015; Yin & Abdullah, 2020). This study aims to quantify the development intensity that has shaped urban growth patterns in KLCC between 2015 and 2023. It will further analyse the influence of these control tools on the resulting saturation, offering critical insights into the efficacy of regulatory frameworks for sustainable urban expansion.

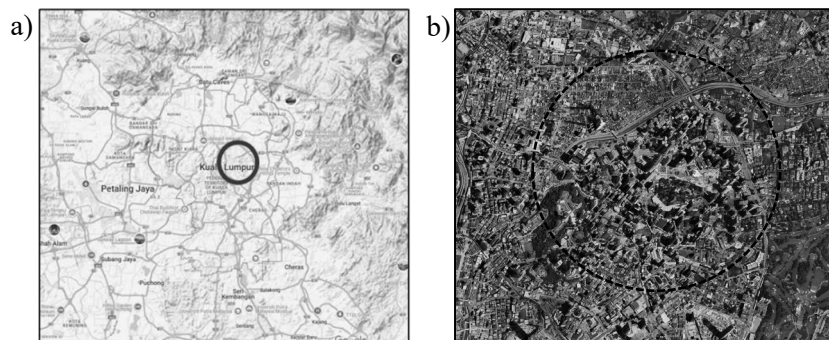


Figure 1: 1km Radius Study Area Kuala Lumpur City Center

Figure 1 shows the study area in this study, which is Kuala Lumpur City Centre. Map (a) shows the location of the study area, which is Kuala Lumpur, and (b) Kuala Lumpur City Centre. The land use (1 km radius) is from KLCC towards Kampung Baru, Bukit Bintang, Bukit Nanas, and Jalan Ampang. Additionally, it demonstrates how Kuala Lumpur's area controls the land use, with commercial as the major development. The total area of Kuala Lumpur City Centre is 247.1 acres in 2024. The red mark on each map indicates the exact pinpoint of the study area. On the eastern and northern edges of the radius lies Jalan Tun Razak, a major ring road facilitating north-south traffic and connecting

to highways leading out of the city. Jalan Kia Peng runs southward from KLCC Park, lined with luxury hotels like the Mandarin Oriental and leading toward the Pavilion shopping area in Bukit Bintang. To the southwest, Jalan Raja Chulan links KLCC to the Bukit Bintang district, passing by commercial offices and intersecting with Jalan Sultan Ismail near Menara KL Tower. Lastly, Jalan Yap Kwan Seng, located north of the Twin Towers, runs parallel to Jalan Ampang and provides access to quieter residential and commercial zones, while also connecting to Kampung Baru and Jalan Tun Razak. Together, these roads form a vital network within this bustling city centre.

PROBLEM STATEMENT

KLCC has led to significant urban issues, including overcrowding, land scarcity, and intense development pressure. The saturation of Kuala Lumpur City Centre (KLCC) is evident, showcasing how urban growth has intensified within this central area. One of the most significant signs of saturation is the high-density development within KLCC. This area is characterised by a concentration of commercial, residential, and leisure spaces, including iconic landmarks such as the Petronas Twin Towers and Merdeka 118. These skyscrapers represent the trend of vertical development, where the limited available land pushes the construction of taller buildings to maximise the use of space. As a result, KLCC's skyline has become defined by high-rise structures, with mixed-use developments that combine office, residential, and retail spaces. This vertical growth is a direct response to the constrained land availability in the area (Aktas et al., 2020; Botti, 2023). Another key factor contributing to the saturation of KLCC is the limited land availability. The scarcity of new land for horizontal expansion forces urban planners and developers to prioritise vertical growth. With no room for outward development, the only option for expanding the urban environment is to build upward. This leads to an increase in building coverage, with a higher portion of the land being developed for buildings. As urban density rises, there is a need to optimise every available space, which is often achieved by constructing taller buildings with larger floor spaces (Al-Kodmany, 2023; Yang & Luan, 2024). The scarcity of land is compounded by the presence of natural barriers and the already developed urban infrastructure that surrounds KLCC. The issue of building saturation in KLCC has become particularly relevant in the context of urban development intensity, where increasing floor space and building height are prioritised over the provision of adequate amenities and public spaces. This shift to vertical development is a clear indicator of saturation, as horizontal expansion becomes impractical due to physical, environmental, and regulatory limitations. The shortage of non-built-up areas, such as parks and recreational spaces, has become a pressing concern, with some areas even experiencing urban problems such as sinkholes due to overdevelopment (Hidayati et al., 2021).

This directly examines how development control influences land use patterns and helps assess the correlation between development intensity and infrastructure demands. In analysing the relationship between development control and saturation patterns in the Kuala Lumpur City Centre (KLCC) 1 km radius, the complexity arises from the regulatory framework that includes zoning regulations, floor space index (FSI), height restrictions, and land use controls, which directly influence development intensity. Defining "saturation" is another challenge, as it can be understood in terms of building density, traffic congestion, or infrastructure limitations, and establishing clear thresholds for saturation that are both physical and functional is subjective and crucial to understanding when further development is no longer feasible, especially in the city centre (Wang et al., 2020; Dong et al., 2023). The area's preference for high-rise buildings, due to limited land availability, further complicates how development controls interact with the saturation pattern, as these controls influence building height, design, and usage (Yin & Abdullah, 2020; Yasin et al., 2022). These issues underscore the need for a nuanced approach to understanding how development control measures affect the intensity of development and the saturation patterns within KLCC.

LITERATURE REVIEW

In this study, urban saturation is operationally defined as the stage at which available land within the study area has been extensively utilised, resulting in limited opportunities for further horizontal expansion and increasing dependence on vertical intensification and redevelopment. Rather than relying on a single indicator, the level of saturation was evaluated using five measurable indicators of urban development intensity: (i) built-up area percentage, (ii) building density (buildings per acre), (iii) average plot ratio, (iv) average building height (storeys), and (v) floor space area. These indicators are widely recognised as reliable measures of development intensity, land-use efficiency, and urban compactness in planning and remote sensing studies (Yin & Abdullah, 2020; Razak & Yin, 2021; Wang et al., 2024; Yang & Luan, 2024). Instead of applying a universal numerical threshold, saturation levels were interpreted comparatively across the 2015–2023 study period based on temporal changes in these five indicators. As urban areas approach saturation, the emphasis of development shifts from horizontal expansion to optimising vertical land use, redeveloping underutilised spaces, and enhancing the efficiency of existing infrastructure. (Li, et al., 2022; Yeo, et al., 2022). Similarly, the percentage of non-saturated areas is derived by subtracting the saturated area from the total area and applying the same proportional formula. These calculations are repeated annually to analyse trends in land-use change over time. Non-saturated areas are urban zones that have not yet reached a high level of development and still have significant potential for

further urbanisation and growth. These areas are generally characterised by available land, which allows for horizontal expansion and the establishment of new infrastructure, residential, and commercial developments (Hu, et al., 2023; Angel, 2023). Unlike saturated areas, non-saturated zones typically experience lower building densities and may still have undeveloped or underdeveloped parcels of land that can be utilised to accommodate future growth. The potential for growth in these areas makes them more flexible in terms of urban development, as they have not yet reached the physical or regulatory constraints that define more saturated environments (Yang, et al., 2021; Wang, et al., 2024). In KLCC, several green spaces serve as non-saturated areas, offering natural vegetation and open spaces amidst urban development. The level of saturation in urban development refers to the stage at which further expansion, particularly horizontal growth, becomes increasingly difficult or unfeasible due to constraints such as limited land availability, infrastructure capacity, and regulatory limits (Wang et al., 2020; Ahani & Dadashpoor, 2021). At this stage, urban areas face significant challenges in accommodating growth without intensifying existing land use or altering the built environment. The level of saturation can vary depending on the stage of urban development, infrastructure capabilities, and the effectiveness of urban planning policies. In such saturated areas, development is primarily managed through regulatory tools such as plot ratios and building height restrictions. These controls are crucial for managing the available space while avoiding overcrowding or infrastructure overload. As the area reaches saturation, building height and density are increasingly restricted to maintain the integrity of the urban landscape and ensure the continued viability of the city's infrastructure (Razak & Yin, 2021; Kadhim et al., 2022).

METHODOLOGY

Figure 2 presents a comprehensive examination of the image processing flow chart utilised to assess urban development intensity and saturation patterns in Kuala Lumpur City Centre (KLCC), based on findings gathered during the site visit at the Malaysian Space Agency (MYSA). The initial phase involves systematic acquisition of high-resolution satellite images of KLCC, covering the years from 2015 to 2023. The comparison will be made between two years, such as 2015-2016 and 2017-2018, and will continue to show how the urban saturation evolved. Satellite images used in this study were obtained from Landsat 8 Operational Land Imager (OLI) and Sentinel-2 MSI. Landsat images have a spatial resolution of 30 m, whereas Sentinel-2 images have a spatial resolution of 10 m. Images acquired between 2015 and 2023 were downloaded from the USGS Earth Explorer. This foundational dataset forms the basis for subsequent analysis, allowing for an examination of changes in land use, the built environment, and overall urban dynamics. Once the satellite images have been acquired, the process

undergoes a thorough preprocessing stage. This involves correcting atmospheric distortions, geometric inaccuracies, and sensor-related artefacts that may obscure the true representation of the urban landscape.

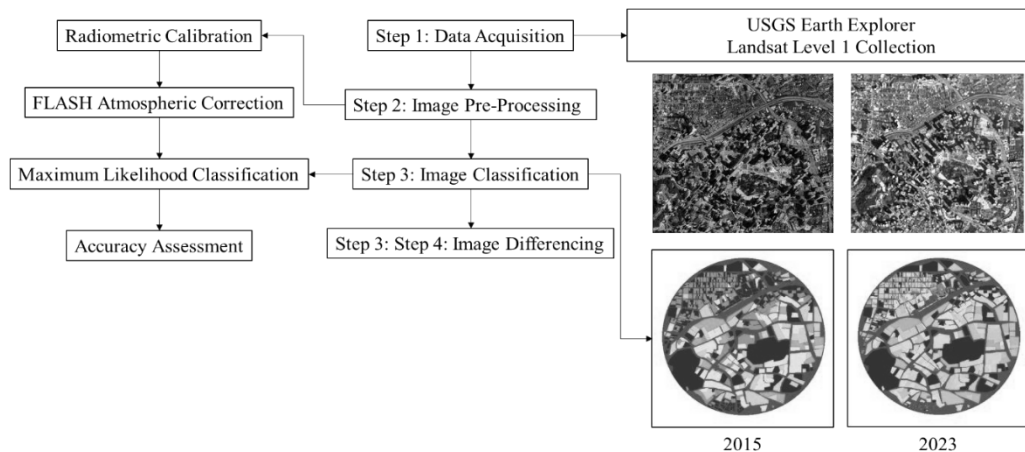


Figure 2: Image Processing of Landsat Image

After pre-processing, the satellite images were enhanced to improve image quality and feature visibility. The preprocessing procedures included radiometric, atmospheric, and geometric corrections, image mosaicking, and clipping to the study area. The enhanced images were then classified into residential, commercial, industrial, and green spaces using supervised and unsupervised classification methods based on spectral characteristics. Supervised classification employed training samples, while unsupervised classification grouped pixels according to spectral similarities. The classified images were subsequently refined through post-classification processing, including majority filtering, ancillary data integration, and class merging, to improve classification accuracy and produce reliable land use maps for analysing spatial distribution and land use changes in KLCC. The post-classification phase is essential for ensuring the reliability of the dataset as it mitigates errors that could undermine the analysis of urban development intensity and saturation. A supervised Maximum Likelihood Classification (MLC) approach was applied to classify built-up and non-built-up land uses in significant change within KLCC. This is accomplished through techniques such as image differencing, post-classification comparison, or change vector analysis. By analysing the transformations in land use and the built environment over the selected years, it becomes possible to pinpoint regions that have experienced notable development, such as new constructions, conversions, or the emergence of green spaces. Change detection is a critical tool

for understanding the dynamics of urban growth and its implications on the saturation of development in KLCC. The insights gained from the classified images and change detection processes are then subjected to comprehensive data analysis. This analysis aims to correlate the observed changes with various influencing factors, such as zoning regulations, infrastructure development, and demographic shifts. By exploring these relationships, it becomes possible to assess the intensity of urban development and identify patterns of saturation that may inform future urban planning initiatives. The analysis not only contributes to a deeper understanding of KLCC's development dynamics but also provides valuable data that can guide policymakers and planners in making informed decisions. The final phase of the image processing workflow involves visualising the analytical results through maps and graphical representations of urban growth, land use changes, and saturation patterns. Both raw satellite images and processed maps are compared to illustrate changes in development intensity over time. The processed images use colour coding to distinguish land use and density levels, where red represents high-density built-up areas, green indicates open or low-density areas, and yellow denotes transitional or medium-density zones. The comparison reveals an increase in high-density development and a reduction in green spaces, providing a clear understanding of urban expansion and the spatial evolution of KLCC. These visual outputs also support the assessment of development intensity and the impacts of development policies. Classification accuracy was evaluated using confusion matrix analysis. The overall classification accuracy exceeded 90%, with a Kappa coefficient above 0.85. While building formula used:

$$\begin{aligned}\text{Building Density} &= \text{Unit of Buildings} / \text{Land Area in Acre} \\ \text{Built-up Percentage} &= (\text{Built-up Area} / \text{Total Area}) \times 100\%\end{aligned}$$

SIGNIFICANCE OF THE STUDY

This study focuses on identifying the key drivers of urban growth and assessing their impact on different subsystems across multiple scales, specifically in the context of KLCC's geographic development. By using these insights, urban planners can anticipate where urban growth is most likely to occur, enabling better preparation for future development. The study provides a comprehensive approach to urban growth management, offering guidance on the identification of areas for expansion, the appropriate intensity of development, and the strategic allocation of land. The study contributes to the advancement of GIS-based remote sensing techniques for urban planning, providing a tool for evaluating the city's growth potential. Additionally, the findings will help to refine policies related to intensity development in key areas in high-rise developments like Merdeka 118

and Exchange 106, ensuring that they align with broader citywide development goals (Rosni et al., 2016; Yu & Fang, 2023).

ANALYSIS AND DISCUSSION

The importance of understanding these saturation dynamics in urban planning, particularly in areas like KLCC, which experience significant development pressures. As urban areas reach higher levels of saturation, there is a direct relationship between land value and the need for densification. Densification refers to the process of increasing the intensity of land use within a given area, typically through taller buildings, increased floor space, and more compact designs. In the context of KLCC, as available land becomes more valuable, developers seek to maximise their return on investment by constructing taller buildings with higher Gross Development Values (GDV) (Lehmann, 2016; Sime Darby, 2023). Part IV of Act 172 explains planning control and mentions several development control methods that approve development (through planning permission) that can result in changes in land use, building, and development intensity. Building alterations must also be approved by the city council, according to Section 19 (2) of Act 172. Many buildings have been altered to expand their height and floor space, resulting in a larger built-up area (Yin & Abdullah, 2020; Razak & Yin, 2021). However, non-saturated areas may also benefit from development incentives that encourage investment and expansion, often in the form of relaxed building regulations or infrastructure support to attract developers and businesses (MIDA, 2022). The development analysis based on the given statement involves a multi-faceted investigation of urban growth patterns and the influence of development control measures within a 1km radius of the Petronas Twin Towers in Kuala Lumpur City Centre. The analysis spans the period from 2015 to 2023 and aims to understand how the intensity of development impacts the evolution of the urban landscape.

Table 1: Comparison Saturated Development Intensity from 2015-2023

Land Use	Average Storey Building (Level)		Average Plot Ratio (FSI)		Building Density (Unit/Acre)		Number of buildings (Unit)		Floor Space Area (acre)		Floor Space Area (acre)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Built-up	50	65	1:09	1:09	12.56	13.38	453	453	67.96	72.92	964.75	1004.36
Non-Built-up	-	-	-	-	-	-	-	-	14.62	9.46	-	-
Year	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Built-up	48	53	1:10	1:10	13.87	13.73	189	223	77.45	76.62	1108.75	1038.77
Non-Built-up	-	0	-	-	-	-	-	-	8.07	5.74	-	-
Year	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Built-up	7	8	1:08	1:08	21.19	19.35	336	386	77.86	92.92	111.35	141.87
Non-Built-up	0	0	-	-	-	-	-	-	4.43	8.53	-	-
Year	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Built-up	51	67	1:10	1:10	25.84	57.67	177	211	70.91	78.08	3407.83	3945.36
Non-Built-up	0	0	-	-	-	-	-	-	6.4	4.33	-	-
Year	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023

Land Use	Average Storey Building (Level)		Average Plot Ratio (FSI)		Building Density (Unit/Acre)		Number of buildings (Unit)		Floor Space Area (acre)		Floor Space Area (acre)	
	65	55	1:10	1:10	65.9	26.09	206	265	16.81	28.68	302.9	460.65
Built-up	65	55	1:10	1:10	65.9	26.09	206	265	16.81	28.68	302.9	460.65
Non-Built-up	-	-	-	-	-	-	-	-	6.1	6.1	-	-
TOTAL							1361	1538	350.61	383.38	5895.58	6591.01

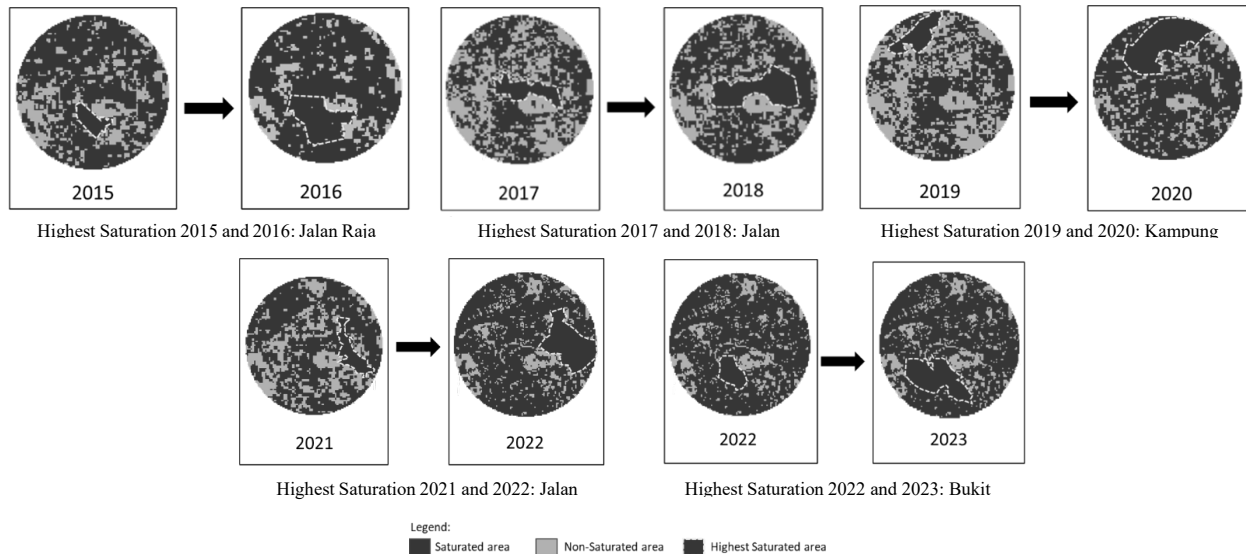


Figure 3: Highest Saturation Development Comparison From 2015-2023

Table 2: Comparison Observation Pattern to KLCP2040

Observed Pattern	KLCP2040
High building density	Allowed
Plot ratio increase	Consistent
Loss of green space	Needs mitigation

Analysis of Saturation Development Pattern in Built-up Area

The analysis of land use changes in Figure 3 and Table 1 between 2015 and 2016 indicates rapid urban intensification, particularly along Jalan Raja Chulan, driven by high-density developments and evolving land use policies. Residential and commercial sectors experienced the most significant growth, reflecting a strong shift toward vertical urbanisation. Residential development saw a sharp increase in average building height from 17 to 27 storeys, alongside an expansion in floor space area, largely due to major projects such as Banyan Tree Kuala Lumpur. Similarly, the commercial sector recorded increased building heights and a substantial rise in floor space area, supported by developments like Pavilion Kuala Lumpur's expansion and the renovation of Sungei Wang Plaza. In contrast, open space areas declined notably, highlighting increasing pressure on green

spaces as urban development intensified. Infrastructure and utilities remained stable, suggesting reliance on existing systems, while institutional, industrial, and facility-related land uses showed slight reductions in floor space, indicating land reallocation or optimisation. Overall, the dramatic increase in total built-up area from 5.48 acres in 2015 to 27.55 acres in 2016 illustrates an aggressive phase of urbanisation. The yellow dashed line emphasises the strong relationship between expanding residential and commercial developments and urban saturation, often at the expense of open spaces.

Between 2017 and 2018, Jalan Ampang became the most saturated development corridor, reflecting rapid urban intensification driven by strategic planning and high-profile developments. Both residential and commercial sectors recorded substantial growth, with increases in building numbers, density, and vertical development. Major projects such as Eaton Residences, Four Seasons Place, Oxley Towers, and KL Trillion significantly contributed to the expansion of floor space and reinforced Jalan Ampang's role as a high-density urban corridor. The total built-up area rose sharply from 12.44 acres in 2017 to 41.33 acres in 2018. Although KLCP2040 encourages high-density mixed-use development within the city centre, the reduction in open spaces indicates increasing development pressure that may require stronger green infrastructure protection (Refer to Table 2). However, this intensification occurred at the expense of open spaces, which declined noticeably, raising sustainability concerns. Other land-use categories, including infrastructure, institutions, and industry, showed minimal change, suggesting reliance on existing facilities. Overall, Jalan Ampang's development saturation reflects efficient land use and strong policy support but highlights the need for a more balanced and sustainable approach to future urban development.

Between 2019 and 2020, Kampung Baru underwent significant development intensification driven by strategic redevelopment initiatives aimed at modernising the area while preserving its cultural identity. The residential sector experienced the most substantial growth, marked by an increase in building numbers and expansion of space and floor areas, primarily through horizontal development associated with affordable housing initiatives such as RUMAWIP. This reflects efforts to address urban housing demand while maintaining lower building densities. Commercial development recorded modest growth under strict planning controls, with projects like the Kampung Baru City Centre (KBCC) introducing new retail and office spaces. Notably, open spaces expanded during this period, indicating a planning emphasis on sustainability and green space preservation under the Kampung Baru Special Area Plan (RKK 2020). Infrastructure, institutional, and industrial sectors also showed measured growth, supported by improved connectivity and upgraded facilities, enabling Kampung Baru to accommodate increasing development pressures. Overall, the total built-

up area increased sharply from 10.01 acres in 2019 to 39.74 acres in 2020, highlighting the transformative impact of coordinated redevelopment projects. These trends demonstrate Kampung Baru's transition toward a modern urban district while maintaining a balanced and culturally sensitive approach to urban development.

Between 2021 and 2022, Jalan Binjai and Jalan Kia Peng experienced intensified urban saturation, driven by the completion of major high-density developments and continued construction despite the COVID-19 pandemic. Residential and commercial sectors showed notable growth, with increases in building numbers, density, and floor space, reflecting strong demand for central urban living and mixed-use environments. Landmark projects such as Merdeka 118, Star Residences, and Oxley Towers played a pivotal role in accelerating this saturation. Infrastructure and utility developments expanded to support growing residential and commercial activity, aided by improved connectivity through MRT infrastructure. Institutional and industrial sectors also increased in building numbers, although within smaller land areas, indicating a trend toward more compact and efficient land use. Conversely, open spaces declined as land was increasingly prioritised for built environments. Overall, the total built-up area increased from 77.31 acres in 2021 to 82.41 acres in 2022, marking a peak phase of urban saturation in these areas. Compared to earlier periods, this phase represents a final push toward high-density urbanisation in central Kuala Lumpur, demonstrating the resilience of urban development driven by strategic projects, infrastructure investments, and evolving market demands.

Between 2022 and 2023, Bukit Bintang experienced a significant intensification of urban saturation, marked by substantial increases in building numbers, floor space area, and land-use transformation. Both residential and commercial sectors recorded major expansion, with sharp growth in total floor space despite declining building densities, indicating a shift toward larger, lower-density or multi-use developments rather than compact high-density structures. Major projects such as The Exchange TRX, Pavilion Kuala Lumpur Extension, and KL118 played a central role in driving this transformation. Residential developments expanded considerably, reflecting increased demand for high-end and spacious urban housing, while commercial growth reinforced Bukit Bintang's role as a key business and retail hub. Open spaces remained constant, suggesting efforts to preserve existing green areas amid rapid development. Infrastructure and institutional sectors showed moderate growth, largely through more compact and space-efficient developments, while industrial activities continued to decline, reflecting land-use reallocation toward higher-value urban functions. The total built-up area increased dramatically from 302.9 acres in 2022 to 460.65 acres in 2023, marking the highest level of urban saturation observed in Bukit Bintang. This growth was facilitated by favourable planning regulations,

development control policies, and large-scale flagship projects. Overall, 2023 represents the peak of urban intensification in Bukit Bintang, characterised by a clear transition toward large-scale, mixed-use developments and highly optimised land use in Kuala Lumpur's city centre.

CONCLUSION

Overall, the analysis of land use changes from 2015 to 2023 reveals a clear trajectory of progressive urban intensification across key areas in central Kuala Lumpur, driven by strategic planning policies, major flagship developments, and evolving market demands. The study period demonstrates a shift from early stages of vertical urbanisation in Jalan Raja Chulan (2015–2016), through rapid corridor-based saturation in Jalan Ampang (2017–2018), to more policy-guided and socially responsive redevelopment in Kampung Baru (2019–2020). From 2021 onwards, development trends in Jalan Binjai, Jalan Kia Peng, and Bukit Bintang indicate a peak phase of urban saturation characterised by large-scale, high-density, and mixed-use developments. Despite disruptions caused by the COVID-19 pandemic, construction activity remained resilient, supported by landmark projects such as Merdeka 118, Oxley Towers, Star Residences, The Exchange TRX and Pavilion Kuala Lumpur Extension. These developments significantly increased building density, floor space, and total built-up areas, reinforcing Kuala Lumpur's role as a compact and vertically orientated global city. Across all study areas, residential and commercial land uses consistently emerged as the dominant drivers of urban growth, often expanding at the expense of open spaces. While some areas, notably Kampung Baru, demonstrated efforts to preserve or enhance green spaces through targeted planning frameworks, the overall trend highlights the growing pressure on open land in highly urbanised zones. Future development should therefore prioritise a balanced approach that integrates high-density growth with environmental sustainability, social inclusivity, and long-term urban liveability. Future development within KLCC should prioritise redevelopment rather than further land consumption. Development control policies should strengthen green infrastructure protection, optimise plot ratio allocation according to infrastructure capacity, encourage transit-orientated development, and preserve strategically important open spaces. Periodic GIS-based monitoring should also be adopted to support evidence-based planning and sustainable urban growth management.

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