



ECONOMIC DRIVERS AND THE DYNAMICS OF INCLUSIVE AND SUSTAINABLE URBANIZATION: AN ASSESSMENT OF MEDAN WITH COMPARATIVE INSIGHT FROM BANGKOK AND MARSEILLE

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Article Info:

- Received: 21/02/2026
- Accepted: 29/09/2026
- Available Online: 30/09/2026

ABSTRACT

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Urbanization can drive economic growth but also increases spatial pressure, environmental risks, and disparities in access to urban services. This research examines how economic structure, investment orientation, and governance capacity shape inclusive and sustainable urbanization in Medan, using Bangkok and Marseille as comparative cases. The study employs a mixed-methods comparative approach, integrating a weighted assessment of ten indicators across governance, investment, economic drivers, and inclusive urbanization, alongside document analysis, GIS-based land-use analysis, and VOSviewer keyword mapping from Scopus and Web of Science. Findings indicate that Medan achieved 5.07% economic growth in 2024, primarily driven by trade, construction, manufacturing, and service sectors. However, the composite assessment reached only 3.00, reflecting challenges within Medan's rapidly evolving urban and environmental spatial structure. Governance and inclusive urbanization scored 2.67 and 2.33, respectively, while investment and economic drivers attained 3.50. Settlement land increased from 18,205.50 ha in 2011 to 20,705.31 ha in 2025, demonstrating significant spatial transformation. Comparative literature analysis shows a greater focus on future mobility and environmental adaptation in Bangkok, whereas research on Marseille emphasizes governance, social inclusion, and sustainability. Overall, the results suggest that economic growth alone is insufficient for achieving inclusive and sustainable urbanization; enhanced green investment, affordable mobility, integrated governance, and spatial coordination are essential.

Keywords: Economic drivers; Governance; Green investment; Inclusive urbanization; Sustainable urbanization

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1. INTRODUCTION

Urbanization drives economic transformation, infrastructure investment, and land-use change. However, economic expansion does not automatically lead to inclusive or sustainable urban development. The benefits of urban growth are often distributed unevenly, and environmental pressures, along with unequal access to urban services, can disproportionately affect vulnerable communities (Schmid, 2024). Achieving inclusive and sustainable urbanization requires attention to both economic performance and the spatial distribution of environmental resources, public amenities, and development opportunities (Elmqvist et al., 2019). Urban green infrastructure (GI), which includes green open spaces and interconnected vegetated areas, matters in this context because it supports ecological functions and enables recreation, physical activity, social interaction, and public health. If green infrastructure provision does not keep pace with population growth and urban development, many residents may remain unable to access its environmental benefits (Baloch et al., 2020). These challenges are especially pertinent in Medan, Indonesia, where economic activities and urban development vary significantly across districts. The city's northern districts offer a valuable context for analyzing the relationship between economic functions and environmental provision. Medan Belawan is characterized by port-related activities and coastal

development, Medan Deli serves as an industrial and employment hub, and Medan Marelan has undergone substantial residential and land-use transformation. These districts are not interchangeable economic centers; their functions, spatial structures, and environmental conditions are distinct. Including these districts enables an examination of how diverse economic and urban development processes intersect with green infrastructure provision within a single urban context (Zhao et al., 2021).

Available studies demonstrate substantial variation in green open space across Medan's districts, although estimates depend on the definition and method used. Reported public green open space areas are 729.73 hectares in Medan Belawan, 53.68 hectares in Medan Deli, and 179.63 hectares in Medan Marelan. These figures represent public green-space areas and should not be interpreted as per-capita availability or as directly comparable measures of all vegetated land. In contrast, a land-cover analysis estimated vegetated land at approximately 42% of Medan Belawan, 32% of Medan Deli, and 37% of Medan Marelan. The differences across these datasets highlight the importance of distinguishing publicly accessible green space from broader vegetation cover. It also indicates why city-wide averages alone may be insufficient for understanding environmental provision at the district level. The relationship between economic activity and green infrastructure is therefore a central issue in Medan. Port-related activities, industrial development, trade, services, and residential expansion may create different demands for land and infrastructure, but their implications for environmental equity require empirical assessment (Paskaleva et al., 2017). The key question is not simply whether economically active districts have more or less green space; rather, it is whether the spatial distribution of economic functions and development pressures corresponds with differences in green infrastructure provision and the inclusiveness of urban development (Sipayung et al., 2019). This district-level perspective also helps avoid assuming that economic importance automatically results in better environmental conditions or, conversely, that economic activity necessarily produces environmental disadvantage. This issue matters because green-space area alone does not determine whether residents can access its benefits (Seto et al., 2012).

Public accessibility, spatial location, population distribution, and the functions of different green spaces affect how environmental resources serve urban communities (Elmqvist et al., 2019). A district may contain substantial vegetated land without providing residents with equivalent access to usable public green space. Conversely, a relatively small area of public green space may serve a dense population and face substantial demand. Accordingly, comparisons across Medan's districts require clear definitions of green infrastructure and indicators that distinguish land-cover extent from public provision and accessibility (Bulkeley et al., 2021). This distinction is necessary to avoid overstating environmental inequality and to ensure that conclusions about inclusion are supported by the scale and type of data analyzed. To situate Medan's experience within a wider context, this study compares it with Bangkok, Thailand, and Marseille, France. Bangkok provides a Southeast Asian metropolitan context, while Marseille offers a European port-city context (Hudalah et al., 2013).

The cities are selected to examine differences in economic structures, urban development pressures, green infrastructure provision, and planning contexts, not to imply that they represent fixed stages of development or that their policies can be transferred directly to Medan. The comparative approach clarifies which patterns are specific to Medan and which may reflect broader challenges in linking economic development with inclusive and sustainable urbanization. Comparisons are interpreted in relation to the available indicators and their definitions, rather than assuming that city-level statistics are automatically equivalent (Yarnvudhi et al., 2021). Although green infrastructure is widely discussed in sustainable urban development, further comparative research is needed on how economic drivers, investment conditions, and spatial planning relate to environmental provision in Indonesian cities (Frantzeskaki et al., 2019). In particular, a framework connecting district-level economic functions in Medan with green infrastructure and comparative urban contexts can contribute to a more spatially grounded understanding of inclusive urbanization (Firman, 2019). This study contributes by linking Medan's internal spatial differentiation to a cross-city perspective, while recognizing that differences in data definitions and urban contexts limit direct equivalence (Hopkins et al., 2018).

This approach provides a basis for discussing how economic development and environmental planning can be considered together, without presuming that economic growth alone ensures equitable environmental outcomes (Schmid, 2024). This study therefore aims to assess the relationship between economic drivers and the dynamics of inclusive and sustainable urbanization in Medan, using Bangkok and Marseille as comparative cases. Specifically, it examines the spatial differentiation of economic activity and green infrastructure in Medan, compares relevant economic and environmental indicators across the three cities, and discusses how these patterns relate to inclusive and sustainable urban development. The study focuses on the implications of these relationships for spatial planning in Medan. By combining district-level analysis within the principal case with a broader comparative perspective, it seeks to provide an evidence-based understanding of the conditions under which economic development and green infrastructure planning may support more inclusive urban outcomes.

2. DATA AND METHODS

2.1. Research Design and Approach

This study used a mixed-methods comparative research design that integrated bibliometric analysis, quantitative indicator assessment, and qualitative interpretation of urban development policies. The research followed two sequential stages. The first stage used bibliometric analysis to identify dominant themes, conceptual relationships, and emerging research directions related to economic development, urban sustainability, green infrastructure, governance, investment, and inclusive urbanization. The second stage translated the study objectives and literature-informed framework into a comparative indicator framework and applied it to Medan, Indonesia, with Bangkok, Thailand, and Marseille, France, as contextual comparators. During the bibliometric stage, VOSviewer was employed to analyze keyword co-occurrence within the selected scientific literature. VOSviewer is specifically designed to construct and visualize bibliometric networks and is widely used to identify thematic structures and relationships within research fields (van Eck and Waltman, 2010). This stage did not assess the performance of the three cities; rather, it established an evidence-based literature structure from which the main analytical dimensions of the empirical assessment were derived. Recent bibliometric studies of sustainable urbanization similarly utilize database-driven literature retrieval, keyword cleaning, threshold selection, and VOSviewer network analysis to establish thematic patterns and research gaps. The empirical stage addressed four analytical dimensions identified from the research framework: governance, investment, economic drivers, and inclusive urbanization. Medan was selected as the principal case, with Bangkok and Marseille serving as contextual comparators.

The three cities were deliberately selected as analytically contrasting urban contexts rather than as equivalent cases. Medan represents a rapidly urbanizing Indonesian city where trade, logistics, construction, and service activities are closely linked to ongoing spatial expansion. Bangkok provides a Southeast Asian metropolitan context in which economic development is increasingly examined alongside mass mobility, environmental management, and urban adaptation. Marseille provides a European port-city context characterized by established maritime, service, industrial, and logistics functions, as well as longer-term urban regeneration and environmental investment. Their contrasting economic structures, urban development pressures, governance settings, and planning responses provide an analytical basis for examining whether the relationship between economic drivers and inclusive and sustainable urbanization varies across different urban contexts. The comparison is therefore not intended to rank the cities or treat one as a developmental model for the others, but to distinguish context-specific conditions from patterns that may be relevant across cities.

Within Medan, the study focused on Medan Belawan, Medan Deli, and Medan Marelan to capture internal spatial differentiation associated with port-related activities, industrial development, and residential and land-use transformation. The mixed-methods design integrates three types of evidence: bibliometric evidence to establish the conceptual structure, quantitative secondary data to provide measurable city-level and district-level conditions, and qualitative documentary evidence to explain the institutional and planning

context underlying the observed patterns. Consequently, this research constitutes a comparative urban assessment informed by bibliometric analysis, rather than a conventional literature review or a purely bibliometric study.

2.2. Data Collection

Two datasets were constructed for the analysis: a bibliographic dataset and an empirical urban dataset. The bibliographic dataset consisted of scientific publications retrieved from the Scopus and Web of Science Core Collection databases using a predefined search strategy covering the concepts of economic drivers, inclusive and sustainable urbanisation, green infrastructure, governance, investment, and urban development. Records retrieved from both databases were screened for relevance, and duplicate records were removed before bibliometric analysis. The resulting dataset was subsequently processed and visualised using VOSviewer to identify keyword co-occurrence patterns, thematic clusters, and the relationships among the main concepts. Prior to network analysis, the keyword dataset was cleaned by merging synonymous terms, singular and plural forms, abbreviations, and spelling variants. A minimum occurrence threshold was applied to retain recurrent terms and reduce noise. The VOSviewer output was then used to identify clusters, central themes, and relationships among concepts. In this study, the resulting map was interpreted as a knowledge-structure map, rather than as evidence of conditions in Medan, Bangkok, or Marseille. This distinction is significant because the VOSviewer map in the current manuscript represents relationships among terms in the literature, such as urban sustainability, urban planning, Marseille, immigration, social housing, governance, and related themes.

The empirical dataset consisted exclusively of secondary data. For Medan, economic and demographic data were obtained from official statistical publications; investment data were obtained from domestic and foreign investment records and government reports; fiscal and governance information was obtained from official financial and administrative documents; and spatial information was obtained from statutory planning documents, land-use datasets, satellite-derived information, and green-space data. The principal spatial units were the city of Medan and, where available, the districts of Medan Belawan, Medan Deli, and Medan Marelan. The comparative dataset for Bangkok and Marseille was compiled from official statistical, urban-planning, investment, environmental, and urban-monitoring sources corresponding to the same analytical dimensions.

The dataset was organized by indicator, value, measurement unit, reference year, geographical boundary, and source. Only indicators with sufficiently comparable definitions and spatial or temporal coverage were used for direct comparison. Where exact equivalence could not be established, the difference was reported as a data limitation rather than concealed through artificial standardization.

2.3. Data Analysis

The quantitative component used a weighted composite scoring method to transform the selected indicators into a common five-point assessment scale. The weighting structure gives equal importance to the four analytical dimensions, while indicators within each dimension receive equal shares of that dimension's weight. The four analytical dimensions and ten indicators were selected based on the study objective and the multidimensional perspective of inclusive and sustainable urbanization. Because the study did not employ expert elicitation or an empirical weighting procedure, equal weighting was applied to the four dimensions, with indicators within each dimension receiving equal shares of the dimension weight in Table 1.

Table 1. Indicator Framework and Weights for the Comparative Assessment

No	Dimenssion	Indicator	Weight
1	Governance	Transparency and accountability (Medan City Government – LPPD/LKjIP and RPJMD documents)	0.0833
		Digital governance (SPBE Index Assessment of Medan City; Medan SPBE Portal)	0.0833

		Institutional capacity (Medan City RPJMD 2021-2026; Medan City RTRW 2022-2042)	0.0833
2	Investment	Economic investment (BPS, Gross Regional Domestic Product of Medan Municipality by Expenditure 2020-2024; Medan investment reports)	0.1250
		Environmental and energy investment (Medan City APBD/financial reports; RPJMD 2021-2026; RTRW 2022-2042_	0.1250
3	Economic Drivers	Economic structure of the city (BPS, Gross Regional Domestic Product of Medan Municipality by Industry 2020-2024)	0.1250
		Investment attraction (domestic and foreign) (DPMPTSP Kota Medan; BKPM investment realization statistics)	0.1250
4	Inclusive Urbanisation	Equity in spatial access (Medan City RTRW 2022-2042; GIS analysis of public facilities and urban services)	0.0833
		Affordability of public mobility (Dinas Perhubungan Kota Medan; BRT Buy The Service (BTS) Medan data; BPS Kota Medan)	0.0833
		Space efficiency and green infrastructure (Landsat/Sentinel imagery; Medan City RTH dataset; RTRW 2022-2042)	0.0833
Total			1.0000

This specification was adopted because the available study design did not include expert elicitation, an Analytic Hierarchy Process, a Delphi procedure, or another empirical method capable of defensibly assigning unequal numerical weights. Equal weighting therefore provides a transparent baseline and avoids imposing unsupported numerical preferences on the dimensions. Composite-indicator methodology emphasizes that weighting and aggregation are methodological choices that should be explicitly documented and tested for robustness.

Each indicator was converted into a five-point scale: 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high. Scores were assigned using predefined indicator-specific criteria based on the relevant numerical value, benchmark, or documented condition. The scoring direction was harmonized so that a higher score consistently represented a more favorable condition for inclusive and sustainable urbanization.

Scoring rules were established prior to aggregation, based on the indicator's numerical value, benchmark, or documented condition. The operational definition, unit, direction, threshold, and source for every indicator should be reported in the revised indicator table or supplementary material. The entire quantitative assessment was calculated using one composite-score equation:

$$C_c = \sum_{(i=1)}^n w_i S_{(ic)}$$

where C_creresents the composite score calculated separately for each city, with creferring to Medan, Bangkok, or Marseille. The term w_irepresents the weight assigned to indicator i, while S_icrepresents the score of indicator ifor city c, measured on a five-point scale from 1 (very low) to 5 (very high). The term n denotes the total number of indicators included in the assessment. Each indicator score is multiplied by its corresponding weight, and the weighted values are then summed to obtain the composite score for each city. Because the sum of all indicator weights equals 1.00 and each indicator is scored from 1 to 5, the resulting composite score theoretically ranges from 1 to 5. A higher composite score indicates a

more favourable overall condition across the indicators included in the assessment. The qualitative component involved systematic analysis of spatial planning, development, investment, environmental, mobility, and governance documents. These documents were coded using the same four analytical dimensions as the quantitative framework. The qualitative evidence elucidated the contexts underlying high or low indicator scores and identified areas where economic development priorities aligned or misaligned with inclusive and sustainable urbanization.

The previous weighting scheme used in the original manuscript (Governance = 0.30, Investment = 0.25, Economic Drivers = 0.25, and Inclusive Urbanization = 0.20) was not retained as the primary weighting structure due to insufficient numerical justification. Instead, it may be reported as an alternative weighting scenario for sensitivity analysis to assess whether the main comparative interpretation changes under a different weighting assumption.

2.4. Spatial and Bibliometric Visualization

The visualization component consisted of two complementary analyses: GIS-based spatial visualization and bibliometric network visualization. GIS was utilized to represent the spatial distribution of selected economic functions, urban development pressures, green infrastructure, and related environmental conditions within Medan. The analysis concentrated on Medan Belawan, Medan Deli, and Medan Marelan as intra-urban cases. Administrative boundaries served as the primary spatial units, while thematic layers were derived from corresponding economic, land-use, green-space, and planning datasets. The spatial workflow included data preparation, spatial overlay, classification, and thematic mapping. The resulting maps were used to identify spatial correspondence and divergence between economic activity and environmental provision. These maps were interpreted as evidence of spatial differentiation, rather than as independent proof of causal relationships. VOSviewer was employed separately to visualize the structure of the scientific literature.

The bibliometric output was generated from the cleaned bibliographic dataset using keyword co-occurrence analysis. Node size indicates a term's relative occurrence, while links represent co-occurrence relationships among terms. Clusters denote groups of terms that occur in close association within the literature. Accordingly, the figure in this study is a VOSviewer keyword co-occurrence network, not a geographical map. The bibliometric map serves a methodological function by establishing the research landscape from which the study interprets the principal concepts of economic development, urban planning, sustainability, governance, and social inclusion. The empirical comparison subsequently examines how these concepts are reflected in the measurable conditions of Medan, Bangkok, and Marseille. This linkage ensures that the bibliometric analysis remains directly relevant to the comparative urban assessment, rather than becoming a disconnected literature exercise.

3. RESULT AND DISCUSSION

3.1. Economic and Urban Development Profile and Indikator-Based Assessment of Medan

Medan has a robust, increasingly service- and logistics-oriented urban economy; however, this expansion is accompanied by disparities in governance, environmental investment, and urban accessibility. Official statistics indicate that Medan's economy grew by 5.07% in 2024, up from 5.04% in 2023. In 2024, wholesale and retail trade and motor-vehicle repair accounted for 26.67% of the city's Gross Regional Domestic Product, with construction contributing 18.41% and manufacturing 14.06%. Transportation and warehousing expanded by 9.51%, while accommodation and food services increased by 14.50%. These data underscore the significance of trade, services, construction, and mobility-related activities within the city's current economic structure. Medan's regional connectivity system strengthens its economic profile. Belawan Port serves as a major maritime gateway, while Kualanamu Airport and the regional road network facilitate the movement of goods and passengers. Within the city, Medan Belawan, Medan Deli, and Medan Marelan exhibit distinct combinations of port-related, industrial, residential, and land-use functions. This internal differentiation matters because economic activity and urban development are not uniformly

distributed across the city. Accordingly, the analysis addresses both the city-wide economic profile and the spatial characteristics of these districts. Medan's economic context contrasts with that of the two comparator cities. Official Thai statistics classify Bangkok as a separate provincial economic unit, enabling analysis of its economic structure at the city level rather than through national data. The 2025 Statistical Yearbook provides Bangkok-specific Gross Provincial Product data, and Bangkok Metropolitan Administration planning documents highlight business and investment activity, tourism, metropolitan mobility, and integrated transport as key components of urban development. Marseille has a port-city economy with a substantial service and trade base. INSEE reports 31,646 employer establishments in 2024, with 72.1% engaged in commerce, transport, and various services. The Port of Marseille Fos reported €99 million in investment in 2024, with activities related to industrial development, logistics, and energy transition

Table 2. Comparative Economic and Urban Development Context of the Three Study Cities

City	Key economic characteristics	Main urban-economic functions	Development orientation
Medan	Economic growth 5.07%; trade 26.67%; construction 18.41%; manufacturing 14.06% of GRDP (Sources: BPS-Statistics of Medan Municipality, 2025 publication / 2024 data)	Trade, logistics, transportation, services, construction; Belawan Port and Kualanamu connectivity	Logistics and transport connectivity, services, construction, urban infrastructure
Bangkok	Bangkok-specific GPP and sectoral statistics are reported separately from other provinces (Sources: National Statistical Office of Thailand, 2025 publication / latest reported data; Bangkok Metropolitan Administration, 2024)	Metropolitan business, trade, tourism, services, investment, mass-transit activities	Mass transit, metropolitan mobility, tourism, business and investment development
Marseille	72.1% of employer establishments are in commerce, transport and various services (Sources: INSEE, 2025 publication / 2024 data; Port of Marseille Fos, 2025 publication / 2024 data)	Port, maritime activity, logistics, trade, services and industry	Port modernisation, industrial activity, logistics and energy transition

The indicator assessment of Medan offers a detailed analysis of the relationship between its economic structure and selected dimensions of inclusive and sustainable urbanization. The revised framework assigns equal weight to the four dimensions, governance, investment, economic drivers, and inclusive urbanization, and distributes each dimension’s weight equally among its indicators. The assessment employs the five-point scale defined in the Methods section.

Table 3. Indicator-Based Assessment of Economic Drivers and Inclusive and Sustainable Urbanization in Medan

No	Dimenssion	Indicator	Weight	Score	Weighted contribution
1	Governance	Transparency and accountability	0.0833	2	0.1667
		Digital governance	0.0833	3	0.2500
		Institutional capacity	0.0833	3	0.2500
2	Investment	Economic investment	0.1250	4	0.5000

No	Dimenssion	Indicator	Weight	Score	Weighted contribution
3	Economic Drivers	Environmental and energy investment	0.1250	3	0.3750
		Economic structure of the city	0.1250	4	0.5000
		Investment attraction	0.1250	3	0.3750
4	Inclusive Urbanisation	Equity in spatial access	0.0833	3	0.2500
		Affordability of public mobility	0.0833	2	0.1667
		Space efficiency and green infrastructure	0.0833	2	0.1667
		Composite score	1.0000		3.00

The results show that economic drivers and investment are the strongest dimensions, both with a dimension score of 3.50. The economic structure receives a score of 4, reflecting the substantial role of trade, construction, manufacturing, transportation, and service activities in Medan's economy. Economic investment also receives a score of 4, corresponding to the strong role of connectivity and infrastructure development in supporting the city's regional economic functions. Investment attraction receives a score of 3, indicating a moderate result within the assessment framework. Environmental and energy investment also scores 3. This distinguishes the strength of general economic and connectivity-oriented investment from the more moderate level of investment specifically associated with environmental and energy-related functions. This distinction matters because the evidence in the manuscript shows a strong concentration of development around ports, airports, toll roads, logistics, services, and construction. The governance dimension scores 2.67. Transparency and accountability score 2, while digital governance and institutional capacity each score 3. The differentiation reflects the evidence used in the assessment: institutional and digital capacities are present, but the integration of information, transparency mechanisms, and cross-sectoral coordination remains incomplete. The previous analysis also identifies limitations in spatial-data integration and evidence-based decision support. The inclusive urbanization dimension records the lowest score (2.33).

Equity in spatial access scores 3, while affordability of public mobility and space efficiency and green infrastructure both score 2. Public mobility affordability therefore represents one of the clearest constraints identified by the indicator assessment. The original data already identified this indicator as the weakest component, particularly given the gap between strong regional connectivity and more limited internal accessibility for urban residents.

The score of 2 for space efficiency and green infrastructure is consistent with the environmental conditions documented in the study. Medan has continued to expand its built-up area, while public green space has not increased at the same pace. The manuscript also documents rising surface temperatures and environmental pressures associated with urban development. The result does not imply that green infrastructure is absent from Medan; rather, within the defined assessment criteria, its performance remains below the stronger economic and investment indicators. The resulting composite score of 3.00 summarises these differences across the ten indicators. Read as an indicator-based description of Medan's current profile, the score highlights these differences. The most pronounced contrast is between the scores of 4 for economic structure and economic investment and 2 for transparency and accountability, public-mobility affordability, and space efficiency and green infrastructure. This pattern establishes the empirical basis for the subsequent city-to-city comparison (Newman & Kenworthy, 1996).

The three cases thus offer distinct empirical contexts for comparative analysis. Medan combines rapid recent economic growth with a robust trade, construction, service, and logistics structure. Bangkok exemplifies a metropolitan context where business, tourism, investment, and mass mobility are major urban functions, with official planning documents emphasizing integrated metropolitan transport and economic development. Marseille features a substantial trade-and-service economy, a major port system, and

documented investment in industrial, logistics, and energy-transition activities. This result establishes the factual baseline for the subsequent comparative section. The same ten indicators, scoring criteria, and weighting structure will be applied to Bangkok and Marseille. This approach enables the identification of measurable differences among the three cities without introducing an unsupported ranking.

3.2. Bibliometric Evidence and Spatial Context of Economic Drivers in Medan

This section integrates bibliometric evidence with Medan's spatial context to clarify how the city's economic drivers align with the broader literature on inclusive and sustainable urbanization. VOSviewer identifies recurring concepts and thematic connections in the literature, while the spatial map locates major economic functions and their surrounding urban conditions. These two forms of evidence complement each other: the bibliometric results establish the research context, and the map provides the geographical context for the principal case. The VOSviewer network for Indonesia and Bangkok places “urban planning” at its center. It connects with “urban sustainability,” “sustainability assessment,” “policy,” and “Southeast Asia.” The Bangkok node is linked to “future mobility” and “foresight,” while “surface urban heat island” is associated with “Landsat 8.” The Indonesia cluster is connected with “policy,” “land price change,” and “global city network.” The pattern shows that research on Indonesia and Bangkok brings together planning, sustainability, policy, mobility, and environmental monitoring (UN-Habitat, 2022). These themes are directly relevant to the present study because they correspond to the mechanisms through which economic development is expressed in spatial change, mobility, and environmental conditions.

This regional network shows an important distinction. Bangkok is more explicitly connected with future mobility and urban heat research, whereas the Indonesia cluster is more closely associated with policy, land-price change, and global-city dynamics. This difference provides a useful Southeast Asian context for Medan. Medan itself does not appear as a distinct high-frequency node, so the network cannot be interpreted as direct bibliometric evidence of conditions in Medan. Instead, it defines the broader regional research setting in which the Medan case is examined.

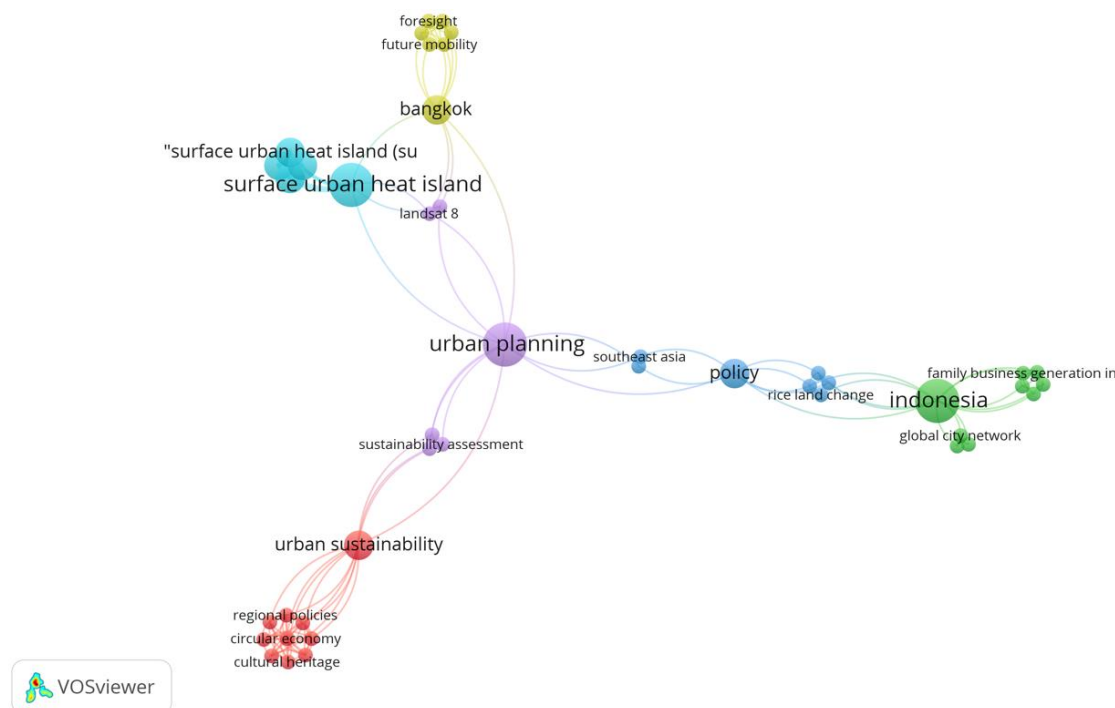


Figure 3. VOSviewer Keyword Co-occurrence Network of Research on Urban Planning, Sustainability, Indonesia, and Bangkok.

The Marseille-oriented network presents a different thematic structure. “Marseille” is closely connected with “immigration,” “ethnicity,” “social housing/HLM,” and “governance,” while “urban planning” links these themes with “urban sustainability,” “sustainable cities,” and “sustainability assessment.” Another cluster contains “circular economy,” “innovation systems,” and “smart cities.” The Marseille literature therefore connects social inclusion and governance with urban sustainability and economic transformation, providing a complementary port-city reference to the mobility- and environment-oriented emphasis around Bangkok (Hopkins et al., 2018)



Figure 4. VOSviewer Keyword Co-occurrence Network of Research on Urban Sustainability and Marseille.

The two bibliometric networks consequently reveal different emphases rather than a common development pathway. Indonesia is associated with policy and spatial-economic change; Bangkok is linked more visibly to mobility and environmental monitoring; and Marseille connects sustainability with social inclusion, governance, innovation, and urban regeneration. These differences support the comparative design without implying that one context represents a universal model for the others. The spatial map places Medan’s economic drivers within its urban structure. Belawan Port occupies the northern coastal zone, KIM I-III represents a major industrial concentration, and the Medan city center functions as a principal commercial and service node. Medan Belawan, Medan Deli, and Medan Marelan highlight different urban and economic settings, while Kualanamu International Airport is shown as a regional connectivity node outside Medan’s administrative boundary. Together, these elements illustrate an economic system organized around port activity, industrial production, central commercial functions, and regional transport connectivity, consistent with Medan’s strong trade, construction, transportation and warehousing, accommodation and food services, and corporate-service sectors.

Bibliometric findings provide broader context for interpreting Medan’s spatial transformation. The Indonesia–Bangkok network links urban planning with sustainability assessment, policy, mobility, and surface urban heat island research. In contrast, the Marseille network connects urban planning with sustainability, governance, social inclusion, and regeneration (Daveci et al., 2021). These patterns demonstrate that economic activity, spatial change, mobility, and environmental quality are interconnected themes within the literature. Consequently, Medan’s land-use transformation serves as a significant spatial context for examining these relationships.

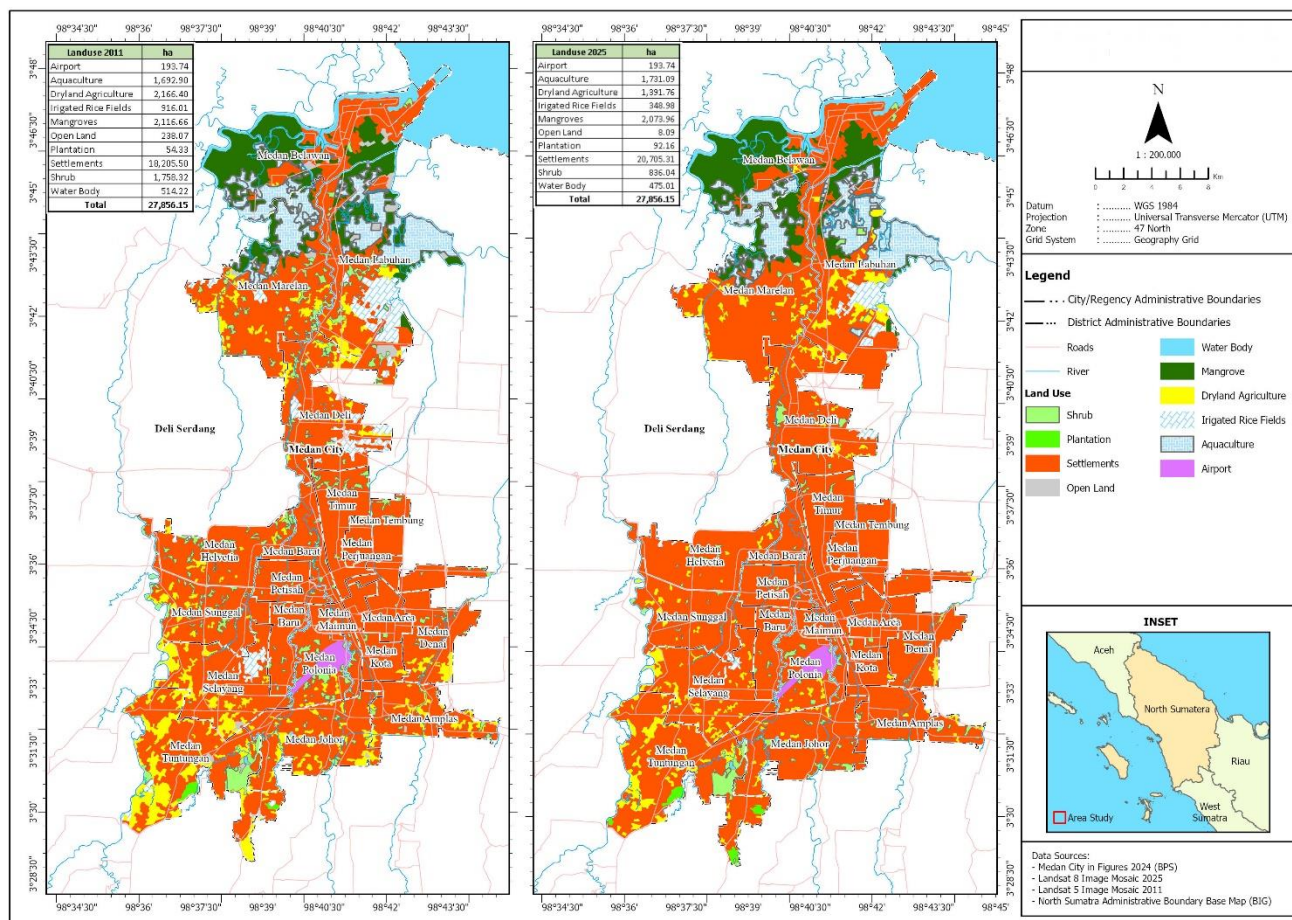


Figure 5. Spatial Transformation of Land Use in Medan City, 2011–2025.

The spatial pattern indicates that settlement and built-up areas dominate much of Medan and have expanded between 2011 and 2025. According to the land-use classification, the settlement area increased from 18,205.50 ha in 2011 to 20,705.31 ha in 2025, an increase of approximately 2,499.81 ha, or 13.73%. This expansion is especially evident in the city's central and northern parts, including Medan Belawan, Medan Deli, and Medan Marelan, where residential, industrial, commercial, and transport functions converge. The growing continuity of built-up areas intensifies urban development pressure and diminishes the spatial continuity of green and open spaces that support inclusive and sustainable urbanization. In northern Medan, port-related and industrial activities coexist with dense settlements, waterways, and coastal ecosystems, resulting in a complex spatial interface between economic functions and environmental resources. The expansion of built-up surfaces also contributes to heat accumulation, aligning with the bibliometric emphasis on surface urban heat island research.

The spatial evidence complements the lower indicator score for space efficiency and green infrastructure. Medan's strong economic structure is accompanied by land-use transformation that pressures inclusive urban spaces and environmental functions. The three focal districts illustrate different manifestations of this process: Medan Belawan reflects the interaction between port-related activity, settlements, and coastal systems; Medan Deli represents an industrial–urban interface; and Medan Marelan shows substantial residential expansion within a changing land-use structure. In comparison, Bangkok is more strongly associated with future mobility and environmental adaptation, while Marseille is linked with governance, social inclusion, sustainability, and port-city regeneration. Medan differs in the way rapid settlement expansion, logistics activity, and fragmented green spaces coexist within the same urban system (Zamyatina et al., 2020). The map therefore reinforces the finding that the central challenge is not the

absence of economic drivers, but their spatial alignment with mobility, green infrastructure, and inclusive urban space (Kong et al., 2012).

The findings extend the interpretation of Medan's urbanization from a conventional economic-growth perspective toward an integrated economic-spatial-institutional framework. Medan has a relatively strong economic structure, particularly in trade, construction, transportation and warehousing, and related services, while the indicator assessment records stronger conditions for economic drivers and investment than for governance and inclusive urbanization (Bulkeley et al., 2021). This pattern suggests that economic drivers do not translate automatically into inclusive and sustainable urban outcomes Melnyk et al., (2020). Their urban effects depend on how investment, governance, mobility, and land are organized. This interpretation aligns with the Global Urban Monitoring Framework, which emphasizes integrating economic, environmental, governance, and spatial dimensions and encourages analysis across urban scales. Land-use transformation in Medan offers a critical spatial explanation for these patterns. The settlement area expanded from 18,205.50 hectares in 2011 to 20,705.31 hectares in 2025, reflecting ongoing conversion to built-up urban uses. Güneralp et al. (2020) demonstrate that global urban expansion typically involves significant land conversion and shifts in urban density, especially in rapidly urbanizing regions. In Medan, this expansion is most evident in the central and northern urban areas, where economic activities, residential settlements, transport infrastructure, and ecological spaces increasingly compete within a limited land system (Newman & Kenworthy, 2019). These findings indicate that economic growth produces a tangible spatial footprint, positioning land-use planning as a key mechanism for translating economic development into urban form (Hopkins et al., 2018).

This result is particularly relevant to flood resilience and environmental planning. Avashia and Garg (2020), drawing on evidence from 42 Indian cities, found that the expansion of built space accompanied declines in green and open spaces and was associated with increased flood risk. Adeola et al. (2025) similarly show that sustainable flood-risk management must consider land-use change alongside planning instruments. For Medan, the score of 2 for space efficiency and green infrastructure therefore reflects more than a shortage of green areas; it captures a broader planning challenge in which built-up expansion, ecological functions, and development demands compete for urban space (Xu et al., 2020). The governance findings provide a second theoretical dimension. Transparency and accountability score 2, while digital governance and institutional capacity score 3. This suggests that the principal constraint is not simply the availability of economic resources, but the institutional capacity to coordinate economic growth with spatial and environmental priorities. In this sense, governance mediates between economic drivers and urbanization outcomes (Acuto et al., 2019).

The framework therefore contributes to urban planning theory by positioning governance not as a separate administrative variable, but as a mechanism that shapes whether economic investment translates into accessible mobility, environmental infrastructure, and inclusive urban space (Gullette et al., 2022). Guidance from the Organization for Economic Co-operation and Development (OECD), the European Union, and the European Commission Joint Research Center (EC-JRC) on composite indicators supports interpreting such multidimensional measures cautiously, because indicator selection, weighting, and aggregation shape the resulting assessment (OECD/European Union/EC-JRC, 2008). Comparative analysis with Bangkok and Marseille further elucidates the contextual nature of these relationships. VOSviewer analysis indicates that Bangkok is frequently associated in the literature with future mobility, environmental monitoring, and surface urban heat, while Marseille is linked to urban planning, sustainability, governance, social inclusion, innovation, and regeneration (Elmqvist et al., 2019). These distinctions suggest that similar urban pressures may require different planning priorities. In Medan, the key issue is the coexistence of a robust logistics and trade economy alongside expanding built-up land and weaker conditions in affordable mobility and green infrastructure. This comparison supports a context-sensitive planning approach rather than a universal model of sustainable urbanization.

The study also shows the need to incorporate land-use transformation into urban economic analysis. Maulani et al. (2024) show that urbanization, population density, and poverty can generate broader social pressures in rapidly changing cities, although their focus is on crime rather than environmental performance.

In Medan, the key insight is that concentrated development can strain accessibility, environmental space, and public services at the same time. This study's theoretical contribution lies in integrating economic drivers, land-use transformation, governance, and inclusive urbanization within a single comparative planning framework. The composite assessment reveals the multidimensional pattern, while GIS and bibliometric evidence clarify its spatial and conceptual context. This framework conceptualizes economic growth as a planning process, with sustainability contingent on effectively translating economic capacity into inclusive and environmentally functional urban space.

4. CONCLUSION

Medan's urbanization is primarily driven by robust trade, logistics, construction, and service sectors. However, this economic strength does not consistently result in inclusive or sustainable urban outcomes. In 2024, economic growth reached 5.07%, and indicator assessments revealed stronger performance in economic structure and investment, while governance and inclusive urbanization remained comparatively weaker. The revised composite assessment assigned Medan an overall score of 3.00, with economic drivers and investment at 3.50 each, governance at 2.67, and inclusive urbanization at 2.33. The lowest scores in transparency and accountability, public-mobility affordability, and space efficiency and green infrastructure highlight the principal areas of imbalance within the urban system. The bibliometric analysis offers additional evidence. The Indonesia–Bangkok network identifies urban planning, policy, mobility, sustainability assessment, and urban heat as interconnected research themes. Conversely, the Marseille network emphasizes urban planning, sustainability, governance, social inclusion, innovation, and the circular economy. These findings situate Medan within a broader comparative context and demonstrate that its primary empirical challenge involves converting strong economic and connectivity functions into accessible mobility and environmental services. The study's contribution is integrating three levels of evidence within a single comparative framework: the literature structure identified using VOSviewer, the indicator-based assessment of economic drivers and inclusive urbanization, and the spatial analysis of Medan's economic nodes and urban pressures compared with Bangkok and Marseille. The weighted measurement facilitates structured comparison, though it does not provide a causal estimate. Medan's principal challenge is not insufficient economic potential, but rather the uneven linkage between economic growth, governance capacity, affordable mobility, and green infrastructure. Strengthening these connections is essential for advancing inclusive and sustainable urbanization.

5. ACKNOWLEDGMENTS

The authors gratefully acknowledge the support of the Architecture Study Program, Faculty of Engineering, Universitas Negeri Medan, for facilitating this research. Appreciation is also extended to the local government institutions of Medan City for providing access to spatial, economic, and planning data essential to this study. The authors thank colleagues and reviewers for their valuable insights and constructive feedback, which helped improve the quality of this manuscript.

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