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A Geospatially Informed Governance Framework for Cross-Boundary Mobility in the Kuala Lumpur–Selangor Metropolitan Region

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Abstract

Cross-boundary commuting between Kuala Lumpur and Selangor has created a functional metropolitan mobility region that extends beyond formal administrative boundaries. Yet responsibility for transport planning, feeder services, land-use decisions, and mobility data remains divided among multiple jurisdictions and agencies. This paper proposes a conceptual framework for understanding how geospatial intelligence can strengthen coordination in metropolitan mobility governance. Drawing on literature on functional urban regions, accessibility, public transport integration, and cross-jurisdictional governance, the framework brings together five key elements: functional mobility demand, geospatial evidence, governance diagnosis, coordinated action, and metropolitan outcomes. Rather than presenting completed GIS or origin-destination analyses, the paper outlines how network mapping, accessibility assessments, land-use overlays, and institutional mapping can be used to identify first- and last-mile gaps, strategic mobility corridors, and barriers to inter-agency coordination. In the Kuala Lumpur-Selangor context, the framework offers a structured foundation for shared data practices, joint corridor planning, coordinated investment, and future empirical testing based on transparent mobility and institutional evidence.

Keywords— cross-boundary mobility, metropolitan governance, geospatial intelligence, conceptual framework, first–last mile integration

I. INTRODUCTION

Rapid urbanisation has pushed metropolitan travel well beyond the administrative boundaries of central cities. Housing, employment, education, commercial activities, and public services are increasingly spread across broader functional regions, creating daily travel patterns that link multiple municipalities and transport systems (Tian et al., 2024; Yasin et al., 2022). As a result, the geographical scale of mobility often extends beyond the administrative scale at which transport, land-use, and infrastructure decisions are planned and implemented.

This mismatch is especially evident in the Kuala Lumpur–Selangor metropolitan region. Kuala Lumpur continues to function as a major centre for employment, education, administration, and services, while neighbouring areas in Selangor accommodate large residential populations, employment hubs, and rapidly developing growth corridors. Travel occurs in both directions, with commuters relying on rail, buses, feeder services, private vehicles, walking, and ride-hailing. Halim et al. (2023, 2025) show that the effectiveness of rail-based mobility depends heavily on reliable feeder services, accessible stations, and smooth connections between different modes of transport. Similarly, Yusoff et al. (2021) stress the need for an integrated transport policy framework across the Klang Valley. Thus, despite significant investment in public transport, the overall network may still underperform when rail services, feeder coverage, pedestrian access, transfer facilities, and land-use development are planned and managed under separate institutional responsibilities.

Cross-boundary mobility is not simply an infrastructure challenge. It is also a matter of metropolitan governance, shaped by fragmented responsibilities, uneven access to information, differing planning cycles, and limited opportunities

for joint priority-setting. Carvalho et al. (2023) argue that urban mobility should be planned at the metropolitan scale, while Miharja et al. (2021) emphasise the importance of sustained collaboration among the authorities responsible for regional transport planning. In a similar vein, Weinreich and Skuzinski (2021) show that weak institutional coordination can lead to disconnected services, overlapping responsibilities, and investment decisions that favour individual jurisdictions rather than the needs of the wider functional travel region.

Geospatial intelligence can help bridge the gap between functional mobility patterns and administrative decision-making. Tools such as network mapping, indicative origin-destination analysis, accessibility measures, land-use overlays, and institutional mapping can reveal where mobility gaps occur and identify the organisations responsible for the affected corridors (Delloye et al., 2026; Hersperger et al., 2024). Against this background, the paper focuses on a central question: how geospatial evidence can support a shared understanding of governance challenges and inform coordinated action. It is therefore presented as a conceptual contribution rather than a completed empirical GIS assessment.

Research question: How can geospatial intelligence support the identification of cross-boundary mobility gaps and inform more coordinated metropolitan mobility governance in the Kuala Lumpur-Selangor region?

The paper introduces a five-stage framework that links functional mobility demand, geospatial evidence, governance diagnosis, coordinated action, and metropolitan outcomes. It aims to clarify the types of evidence needed, explain how spatial and institutional gaps can be examined together, and illustrate how agencies can turn a shared diagnosis into coordinated, corridor-based decisions. The framework also provides a clear and transparent foundation for future empirical testing.

II. CONCEPTUAL FOUNDATIONS

A. Functional Mobility Beyond Administrative Boundaries

A functional mobility region is shaped by recurring travel patterns rather than by a single legal or administrative boundary. Daily commuting flows connect residential areas with employment centres, educational institutions, commercial districts, and major interchange nodes across the wider metropolitan area. Rodríguez et al. (2022) illustrate how mobile-positioning data can be used to identify such functional areas, while Zhang et al. (2022) show that cross-boundary urban regions often extend beyond officially defined municipal territories. Similarly, Bogomolov et al. (2024) demonstrate that intraday commuting patterns can reveal urban structures that are broader and more dynamic than administrative boundaries suggest. This distinction is important because a transport corridor may function as one integrated travel system even though its stations, roads, feeder routes, and surrounding development are managed by several different authorities.

For public transport users, what matters most is the quality of the entire journey, not the administrative area in which each part of it takes place. Even where rail capacity is sufficient, practical accessibility can still be limited by poor pedestrian connections, inadequate feeder services, inconvenient transfer points, or inaccessible station environments. Ramli et al. (2022) emphasise the importance of walkability and first- and last-mile conditions in making public transport genuinely accessible, while Halim et al. (2023) highlight the role of feeder services and station catchment areas in strengthening rail connectivity. The analysis should therefore consider the full journey from origin to destination, rather than ending at an administrative boundary.

B. Metropolitan Governance and Institutional Fragmentation

Metropolitan mobility governance refers to the way public authorities, transport operators, planning agencies, and other stakeholders coordinate decisions across administrative boundaries. Fragmentation arises when responsibilities are divided among different organisations without effective systems for aligning plans, sharing data, coordinating services, or funding cross-boundary initiatives. Weinreich and Skuzinski (2021) show that formal institutional structures alone are not enough to ensure integrated services across jurisdictions, as effective coordination also depends on stable relationships between organisations. Likewise, Zimmermann et al. (2023) stress the need for shared metropolitan priorities and governance mechanisms that can align responsibilities across different levels of administration.

In practice, governance gaps may take the form of uneven feeder-service coverage, disconnected pedestrian routes, poorly coordinated timetables, conflicting land-use decisions, or uncertainty over which agency is responsible for addressing problems in boundary areas. Adopting a metropolitan approach does not mean removing the authority of local governments. Rather, it involves creating a coordinating layer that connects local responsibilities with regional travel patterns and enables joint decision-making for corridors whose costs and benefits extend across several jurisdictions. Carvalho et al. (2023) highlight the importance of planning mobility at the metropolitan

scale, while Hersperger et al. (2024) show how interconnected planning frameworks can align policies, responsibilities, and decisions across jurisdictional boundaries.

C. Geospatial Intelligence as Shared Evidence

Geospatial intelligence brings together location-based data, analytical techniques, and visualisation tools to support interpretation and informed decision-making. In mobility planning, it allows transport networks, station locations, travel flows, land use, population distribution, and accessibility conditions to be examined within a single analytical framework. Hardi and Murad (2023) show that spatial accessibility analysis can reveal areas that are physically close to public transport but remain difficult to reach because of weak pedestrian connections, limited feeder services, or inadequate transfer facilities. Farooq et al. (2026) similarly demonstrate the value of GIS-based methods in identifying accessibility gaps within congested urban transport systems. Geospatial analysis can also be strengthened through the integration of multiple data sources. Graells-Garrido et al. (2023), for example, show how mobile-phone data can complement conventional travel surveys, while Lemonde et al. (2021) highlight the value of combining multimodal traffic data to develop a more complete understanding of urban mobility patterns.

The main governance value of geospatial evidence lies in its ability to provide a shared spatial reference for decision-making. A mapped transport corridor or accessibility gap can be examined by transport operators, local authorities, land-use planners, and funding agencies within the same geographical context. Attah et al. (2024) note that GIS and data analytics can strengthen public-sector decision-making by providing spatial evidence for urban planning and infrastructure management. However, maps alone cannot resolve institutional fragmentation. The evidence must also be linked to agency mandates, decision-making procedures, and implementation responsibilities. The proposed framework therefore positions geospatial analysis as part of a broader metropolitan governance system rather than as a standalone solution.

III. METHODOLOGY

A. Conceptual Research Design

This paper uses an integrative conceptual approach. It draws together the 20 peer-reviewed and scholarly sources cited in the manuscript, selected for their relevance to functional urban regions, cross-boundary commuting, public transport accessibility, first- and last-mile integration, metropolitan governance, and geospatial decision support. The Kuala Lumpur-Selangor region serves as the applied context for organising the relationships among these themes. The review is interpretive rather than systematic and does not aim to provide exhaustive coverage of the literature. The study also does not collect primary mobility data, calculate accessibility indicators, or present completed origin-destination or GIS analyses.

The framework was developed in four stages. First, the literature was reviewed to identify recurring mobility challenges linked to administrative fragmentation. Second, different forms of geospatial evidence were grouped according to the planning questions they could help address. Third, institutional issues were organised into a governance diagnosis covering agency mandates, service responsibilities, data availability, and coordination capacity. Finally, these elements were linked to possible governance actions, monitoring needs, and metropolitan outcomes. Together, the stages trace a clear progression from identifying the mobility problem to gathering evidence, diagnosing governance gaps, designing interventions, and evaluating their results.

B. Kuala Lumpur–Selangor Study Context

The study focuses on Kuala Lumpur and its cross-boundary mobility connections with neighbouring local authority areas in Selangor, including Petaling Jaya, Subang Jaya, Shah Alam, Selayang/Gombak, Ampang Jaya, and Kajang/Cheras. Together, these areas form an interconnected metropolitan system in which commuting patterns, transport services, and urban development regularly extend across administrative boundaries. Figure 1 presents the Kuala Lumpur administrative boundary, selected surrounding jurisdictions, major rail corridors, key interchange nodes, and indicative directions of cross-boundary movement. The arrows are not intended to represent measured commuting volumes. Instead, they illustrate the spatial relationships that support a metropolitan approach to mobility planning.

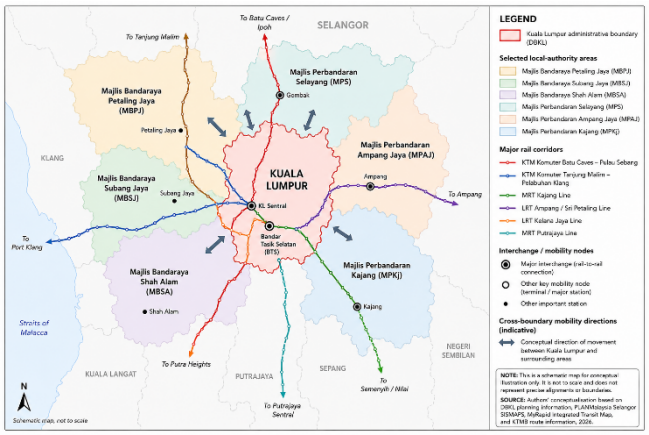

Fig. 1. Schematic Kuala Lumpur–Selangor metropolitan study context showing selected local-authority areas, major rail

corridors, key mobility nodes, and indicative cross-boundary mobility directions. Source: Authors' conceptualisation based on DBKL planning information, PLANMalaysia Selangor SISMAPS, MyRapid Integrated Transit Map, and KTMB route information, 2026.

C. Analytical Domains

The framework is organised around five analytical domains. The examples provided are indicative and do not suggest that all relevant datasets have already been collected. Each domain is connected to a specific planning question and governance purpose, helping to align the conceptual approach with the analysis presented in the following sections.

i. **Functional demand**: Origin-destination patterns, trip purposes, and peak travel flows help define the functional scale of the metropolitan region and identify priority mobility corridors.

ii. **Network and access**: Rail, bus, feeder, walking, and transfer connections are examined to identify gaps in coverage, interchange quality, and first- and last-mile accessibility.

iii. **Land use and activity**: The distribution of residential areas, employment centres, educational institutions, and public services helps determine whether transport provision matches the locations that generate travel demand.

iv. **Jurisdiction and mandates**: Administrative boundaries, agency responsibilities, planning documents, and funding arrangements are used to identify overlapping roles, unclear ownership, and barriers to coordination.

v. **Monitoring**: Indicators relating to accessibility, service quality, equity, data sharing, and implementation progress support the evaluation and ongoing refinement of joint interventions.

D. Framework Construction

The proposed framework consists of five interconnected stages, as shown in Figure 2. It begins with functional mobility demand, which defines the actual scale and pattern of metropolitan travel. Geospatial evidence is then used to examine how transport networks, accessibility, land use, and administrative boundaries interact. The governance diagnosis stage connects the spatial gaps identified to agency mandates, service responsibilities, data constraints, and coordination challenges. These findings then inform coordinated action, including shared data arrangements, corridor-based planning, first- and last-mile priorities, and better alignment of investment decisions. Finally, metropolitan outcomes are assessed in terms of efficiency, equity, accessibility, and climate responsiveness, while ongoing monitoring provides feedback for refining the framework over time.

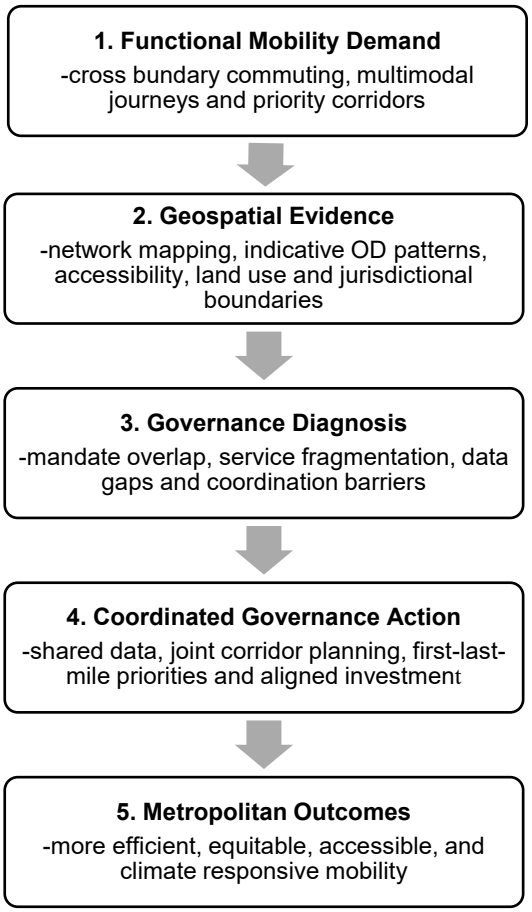

Fig. 2. Proposed geospatially informed metropolitan mobility governance framework. Source: Authors

IV. CONCEPTUAL SYNTHESIS AND DISCUSSION

A. Functional Demand Should Define the Planning Scale

The first proposition is that metropolitan mobility planning should be shaped by actual travel demand rather than jurisdictional boundaries. In the Kuala Lumpur–Selangor region, priority corridors are those that connect residents to employment, education, services, and major interchange nodes in both directions. This approach does not overlook administrative boundaries. Instead, it reveals where those boundaries divide journeys that function as part of the same travel system. It also provides a clearer and more transparent basis for prioritising corridors with substantial cross-boundary movement, frequent transfers, or a strong reliance on feeder services.

B. *Geospatial Evidence Can Create a Common Diagnosis*

The second proposition is that geospatial evidence can provide a shared language for diagnosing mobility problems. Network mapping can expose gaps between rail, bus, feeder, and pedestrian systems, while indicative origin-destination patterns can highlight areas with strong travel demand. Accessibility assessments can identify poorly connected communities, and land-use overlays can reveal whether transport services align with concentrations of housing, employment, education, and public services. Taken together, these spatial layers turn a broad mobility concern into a more precise corridor-level diagnosis by showing where the problem occurs, which connections are missing, and which organisations are involved.

C. *Spatial Gaps Must Be Linked to Institutional Responsibilities*

The third proposition is that a spatial diagnosis remains incomplete unless it is tied to institutional responsibility. A single accessibility gap may involve several actors, including a transport operator, a local authority responsible for pedestrian infrastructure, a land-use planning agency, a road authority, and a funding body. Institutional mapping should therefore clarify who manages the relevant assets, who holds the necessary data, which plans apply to the area, and where responsibilities overlap or remain uncertain. By making these relationships visible, a descriptive map becomes a practical coordination tool. It also helps explain whether a mobility gap persists because of limited evidence, fragmented responsibilities, competing priorities, or the absence of a joint decision-making mechanism.Figure 3 operationalises this relationship by connecting illustrative mobility gaps with their geospatial diagnosis, governance implications, and coordinated responses

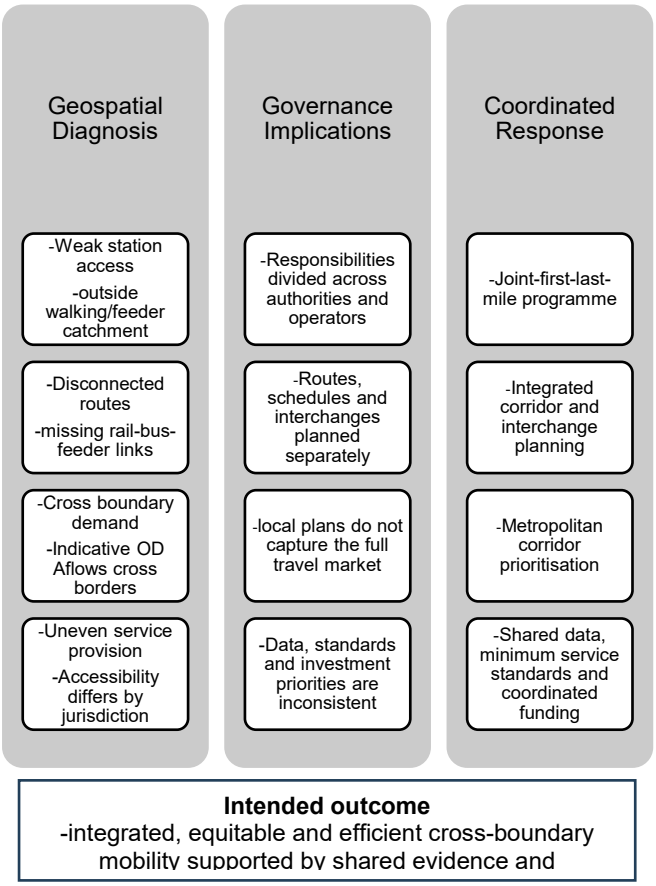

Fig. 3. Translation of geospatially identified mobility gaps into governance and planning responses. Source: Authors'

D. *Coordinated Action Should Be Corridor-Based and Iterative*

The fourth proposition is that coordinated action should be organised around functional corridors and supported by continuous monitoring. A corridor-based approach allows agencies to coordinate feeder services, station access, pedestrian improvements, interchange design, service schedules, and surrounding land-use decisions across the entire journey. It also provides a practical basis for agreeing on responsibilities, budgets, timelines, and performance indicators. The framework is designed to be iterative, as implementation generates new evidence on service use, accessibility, transfer performance, and institutional cooperation. This evidence can then be used to refine the shared diagnosis and adjust priorities over time.

V. IMPLEMENTATION PRIORITIES AND FUTURE RESEARCH

A. *Shared Metropolitan Mobility Data*

A practical starting point would be to establish a shared metropolitan mobility data arrangement. This does not necessarily require the immediate creation of a single centralised database. Instead, agencies could begin by agreeing on common data

definitions, update schedules, metadata standards, access protocols, and a shared spatial reference for priority corridors. The resulting evidence base should bring together information on transport provision, station access, feeder-service coverage, land use, jurisdictional boundaries, and selected indicators of travel demand, with clear responsibility assigned for managing each dataset.

B. Joint Corridor Planning

Priority corridors should be identified using clear and transparent criteria, including the level of cross-boundary demand, reliance on transfers, accessibility gaps, equity concerns, and the feasibility of implementation. Corridor-based working groups could then bring together the relevant local authorities, transport operators, planning agencies, and infrastructure bodies to develop coordinated packages of interventions rather than pursuing isolated projects. Adjusting a feeder service, for instance, may also require safer pedestrian access, better interchange design, consistent passenger information, and more closely aligned land-use management.

C. Monitoring, Validation, and Empirical Testing

As this paper is conceptual, its propositions will need to be tested empirically. Future research could apply the framework to selected corridors across Kuala Lumpur and Selangor using clearly documented datasets, study periods, spatial units, indicators, and analytical procedures. Possible methods include network-based station catchment analysis, multimodal travel-time accessibility assessment, origin-destination flow mapping, land-use and population overlays, as well as interviews or document analysis focused on institutional mandates. Such research would help determine whether the relationships proposed in the framework adequately explain observed mobility gaps and coordination challenges.

Evaluation could draw on indicators such as access to public transport, transfer times, feeder-service coverage, pedestrian connectivity, service reliability, user equity, data-sharing performance, and the completion of jointly agreed actions. The study is also limited by its non-systematic review of the literature and the absence of measured mobility and institutional data. However, these limitations point to the next stage of research rather than weakening the value of the conceptual contribution.

VI. CONCLUSION

Cross-boundary mobility between Kuala Lumpur and Selangor functions as an integrated metropolitan system, even though planning and service responsibilities remain divided among different jurisdictions and agencies. The central challenge is therefore not simply the provision of transport, but the mismatch between the geography of everyday travel and the geography of decision-making. This paper addresses that mismatch through a five-stage conceptual framework linking functional mobility demand, geospatial evidence, governance diagnosis, coordinated action, and metropolitan outcomes. Its main contribution lies in showing how spatial evidence can support institutional coordination. Network, accessibility, indicative origin-destination, and land-use data can help identify where mobility gaps are likely to occur, while institutional mapping can explain why those gaps persist and which organisations need to work together.Shared data arrangements, corridor-based planning, coordinated investment, and continuous monitoring provide a pathway from diagnosis to implementation. The paper does not present completed empirical findings, and future research will need to test the framework using transparent mobility datasets, spatial indicators, and institutional evidence. Even at this conceptual stage, however, the framework offers a structured basis for organising mobility decisions around the journeys people make rather than the administrative boundaries they cross.

REFERENCES

[1] Attah, R. U., Garba, B. M. P., Gil-Ozoudeh, I., & Iwuanyanwu, O. (2024). Leveraging geographic information systems and data analytics for enhanced public sector decision-making and urban planning. Magna Scientia Advanced Research and Reviews, 12(2), 152–163. https://doi.org/10.30574/msarr.2024.12.2.0191

[2] Bogomolov, Y., Belyi, A., & Sobolevsky, S. (2024). Urban delineation through a prism of intraday commute patterns. Frontiers in Big Data, 7, 1356116. https://doi.org/10.3389/fdata.2024.1356116

[3] Carvalho, J. L., de Sousa, J. P., & Macário, R. (2023). Sustainable urban mobility planning at the metropolitan scale: A review of current practices and narratives. Transportation Research Procedia, 72, 4175–4182. https://doi.org/10.1016/j.trpro.2023.11.357

[4] Delloye, J., Klein, S., Klein, O., Drevon, G., Jacquot, M., Rapp, V., Cornélis, E., Rousseaux, J., Schiebel, J., Besch, G., Godefroy, S., & Gerber, P. (2026). Improving the understanding of mobility in cross-border areas using a pooled travel survey. Transportation, 53, 1–33. https://doi.org/10.1007/s11116-024-10488-3

[5] Farooq, D., Iqbal, H. W., Masoud, M., Haider, T., Abbas, H., Riaz, M. A., & Asghar, M. A. (2026). Optimization of public transport route accessibility in high congestion areas using Arc GIS: A case study of Rawalpindi City. Periodica Polytechnica Transportation Engineering, 54(1), 24–33. https://doi.org/10.3311/PPtr.39867

[6] Graells-Garrido, E., Opitz, D., Rowe, F., & Arriagada, J. (2023). A data fusion approach with mobile phone data for updating travel survey-based mode split estimates. Transportation Research Part C: Emerging Technologies, 155, 104285. https://doi.org/10.1016/j.trc.2023.104285

[7] Halim, M. A., Rosni, N. A., & Teh, B. T. (2023). Conceptual framework for maximizing service

catchment area between rail transit and feeder service using spatial temporal regression technique. IOP Conference Series: Earth and Environmental Science, 1240(1), 012010. https://doi.org/10.1088/1755-1315/1240/1/012010

[8] Halim, M. A., Rosni, N. A., & Teh, B. T. (2025). Preliminary insights into feeder bus usage: A case study of Asia Jaya LRT Station in the Klang Valley. Journal of Design and Built Environment, Special Issue VI, 74–88. https://doi.org/10.22452/jdbe.spVI.4

[9] Hardi, A. Z., & Murad, A. A. (2023). Spatial analysis of accessibility for public transportation: A case study in Jakarta, Bus Rapid Transit System (TransJakarta), Indonesia. Journal of Computer Science, 19(10), 1190–1202. https://doi.org/10.3844/jcssp.2023.1190.1202

[10] Hersperger, A. M., Sciara, G.-C., Bacău, S., Imhof, C. S., & Zhao, C. (2024). Governing urban regions with a network of plans. Cities, 146, 104683. https://doi.org/10.1016/j.cities.2023.104683

[11] Lemonde, C., Arsenio, E., & Henriques, R. (2021). Integrative analysis of multimodal traffic data: Addressing open challenges using big data analytics in the city of Lisbon. European Transport Research Review, 13, 64. https://doi.org/10.1186/s12544-021-00520-3

[12] Miharja, M., Woltjer, J., Arsallia, S., & Diab, A. H. (2021). Bandung metropolitan transportation planning collaboration and perceived transaction cost changes after 2 decades of decentralization. International Journal of Technology, 12(3), 506–517. https://doi.org/10.14716/ijtech.v12i3.4345

[13] Ramli, R., Yaacob, N. M., & Zainol, R. (2022). Walkability assessment of first mile last mile public transport system of neighbourhood in Kuala Lumpur, Malaysia and Singapore for persons with disabilities: A comparative study. Journal of Design and Built Environment, 22(3), 1–22. https://doi.org/10.22452/jdbe.vol22no3.1

[14] Rodríguez, M., Molina, J., & Camacho, J. A. (2022). Mapping functional areas in Spain using mobile positioning data. European Urban and Regional Studies, 29(2), 145–151. https://doi.org/10.1177/09697764211066258

[15] Tian, Y., Kan, C., Li, X., & Dang, A. (2024). An analysis of agglomeration structure for Beijing, Tianjin, and Hebei based on spatial-temporal big data. Computational Urban Science, 4, 11. https://doi.org/10.1007/s43762-024-00122-4

[16] Weinreich, D., & Skuzinski, T. (2021). Organizing transit institutions to facilitate cross-jurisdictional service integration: A multi-region comparative case study. Journal of Urban Affairs, 43(9), 1330–1354. https://doi.org/10.1080/07352166.2020.1722031

[17] Yasin, M. Y., Zain, M., & Hassan, M. H. (2022). Urbanization and growth of Greater Kuala Lumpur: Issues and recommendations for urban growth management. Southeast Asia: A Multidisciplinary Journal, 22(2), 4–19. https://doi.org/10.1108/SEAMJ-02-2022-B1002

[18] Yusoff, I., Ng, B., & Azizan, S. A. (2021). Towards a sustainable transport policy framework: A rail-based transit system in Klang Valley, Malaysia. PLOS ONE, 16(3), e0248519. https://doi.org/10.1371/journal.pone.0248519

[19] Zhang, B., Zhong, C., Gao, Q., Shabrina, Z., & Tu, W. (2022). Delineating urban functional zones using mobile phone data: A case study of cross-boundary integration in the Shenzhen–Dongguan–Huizhou area. Computers, Environment and Urban Systems, 98, 101872. https://doi.org/10.1016/j.compenvurbsys.2022.101872

[20] Zimmermann, K., Leonel, A. L., & Kontopp, M. A. (2023). Metropolitan governance in the context of dynamic urbanization: The case of Brazil. Frontiers in Political Science, 5, 1148522. https://doi.org/10.3389/fpos.2023.1148522