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Aligning smart mobility with institutional capacity: Evidence-based transport policy strategies for sustainable urban mobility in developing cities

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Abstract: *Purpose.* This study examines how urban transport policy in developing cities can align smart mobility initiatives with institutional and system capacity to support sustainable urban transportation. Using South Africa as an analytically representative context, it identifies strategic priorities and explores emerging patterns that may guide capacity-sensitive smart mobility implementation. *Methodology.* A quantitative cross-sectional survey was conducted among 201 urban transport stakeholders. Descriptive statistics ranked 14 smart mobility strategies, while exploratory principal component analysis with oblique rotation examined potential strategic groupings. Given marginal factorability diagnostics, the component analysis was interpreted cautiously and used only for exploratory purposes. *Results.* Digital and ICT infrastructure, cybersecurity frameworks, smart mobility regulations, and unified data standards received the highest aggregate rankings. User-facing interventions, including Mobility-as-a-Service integration, electric vehicle charging networks, and behaviour-change programmes, received slightly lower ratings. The exploratory analysis suggested three provisional patterns: smart mobility infrastructure enablement, policy and institutional support, and collaborative data-driven mobility innovation. The findings indicate that institutional readiness may act as a gating condition for the effective adoption and scaling of smart mobility initiatives. *Theoretical contribution.* The study advances sustainable urban mobility and socio-technical perspectives by proposing a capacity-first sequencing proposition, whereby digital, regulatory, organisational, and data-governance capabilities should be developed before large-scale deployment of integrated mobility technologies. *Practical*

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implications. Policymakers and urban transport authorities should prioritise secure digital infrastructure, interoperable data standards, regulatory clarity, institutional coordination, and skills development before scaling MaaS platforms, advanced analytics, and electric mobility interventions.

Keywords: developing cities, institutional capacity, smart mobility, sustainable transportation, urban transport policy

Sustainable Development Goals (SDGs): SDG 9: Industry, Innovation and Infrastructure; **SDG 11:** Sustainable Cities and Communities; **SDG 13:** Climate Action

1. Introduction

Urban transport systems in developing cities are under increasing strain as rapid urbanisation, motorisation, and spatial expansion outpace the capacity of existing infrastructure and planning frameworks. More than 60 per cent of global urban population growth projected between 2020 and 2040 is expected to occur in low- and middle-income countries, particularly in Africa and Asia (Aboulnaga et al., 2021). This growth has intensified daily travel demand, while many cities still rely on outdated road networks and informal transport services. Consequently, congestion in cities such as Lagos, Nairobi, Dhaka, and Manila regularly exceeds acceptable thresholds, and average commute times continue to rise (Luitel et al., 2025a; 2025b). The economic costs are substantial. In India, for example, Sahu et al. (2022) report that infrastructure inefficiencies account for about 4 per cent of gross domestic product in logistics costs, illustrating the broader productivity burden of inefficient transport systems. At the same time, the transport sector remains a major source of urban air pollution and greenhouse gas emissions, accounting for nearly one-quarter of global energy-related carbon dioxide emissions (Chovancová et al., 2023; Kumbhar et al., 2025). These pressures call for policies that balance mobility needs with environmental and social sustainability. Such policies directly support Sustainable Development Goal (SDG) 9 on resilient infrastructure, SDG 11 on inclusive and sustainable cities, and SDG 13 on climate action.

In response, smart mobility technologies have been promoted as potential enablers of more efficient and sustainable urban transport systems. Oladimeji et al. (2023) define smart mobility as encompassing tools such as intelligent transport systems, traffic management platforms, real-time passenger information, integrated ticketing, and shared mobility services. Evidence suggests that, when properly implemented, these technologies can reduce congestion, improve service reliability, and support a modal shift toward public and non-motorised transport (Okoro & Lawani, 2022; Mutambik, 2025). For example, adaptive traffic signal control and real-time bus tracking can improve travel times along urban corridors (Li et al., 2023; Mutambik, 2025). However, the effectiveness of smart mobility solutions depends heavily on local conditions. In many developing cities, limited data availability, weak digital infrastructure, and fragmented governance constrain the planning, operation, and scaling of these technologies (Das, 2025; Stephen et al., 2025). Without alignment with institutional capacity and planning objectives, smart mobility may remain a collection of isolated pilot projects rather than a driver of systemic change.

According to Deweerdt & Fabre (2022), urban transport policy plays a critical role in shaping how technology interacts with planning, land use, and economic objectives. Sustainable transport outcomes are more likely when policies are informed by empirical evidence and embedded within coherent planning frameworks that integrate land use, infrastructure investment, and service regulation. Rubio & Ruiz (2025) and Mangara & Dorasamy (2026) added that in developing cities, however, transport policy is often reactive rather than strategic, responding to congestion and service failures without addressing underlying structural issues such as informal service dominance, weak regulatory enforcement, and limited interagency coordination. Several studies also note that institutional fragmentation among transport authorities, municipal governments, and national agencies undermines long-term planning and technology integration (Yang et al., 2025; Xin & Qian, 2025). As a result, policy frameworks frequently fail to translate the potential of smart mobility into measurable improvements in accessibility, safety, and environmental performance.

Despite growing academic and policy interest in smart mobility, significant gaps remain in understanding how developing cities can design evidence-based strategies that reflect their institutional and system capacities. Much of the reviewed literature prioritises either technological innovation or broad sustainability principles, while the policy mechanisms that connect ambition to implementation receive limited attention. Empirical studies also rarely examine how institutional constraints, planning practices, and system capacity jointly shape smart mobility outcomes in developing contexts. This study addresses these gaps by examining how urban transport policy can be recalibrated to support sustainable mobility in developing cities. It aims to develop evidence-based planning strategies that align smart mobility initiatives with institutional capacity and system performance. The objectives are to identify key institutional and operational constraints affecting smart mobility adoption, assess how empirical planning approaches can strengthen policy design, and propose context-sensitive strategies for sustainable urban transport. The study further advances a provisional capacity-first sequencing proposition: foundational digital, regulatory, and organisational capacity should precede the large-scale deployment of integrated, user-facing mobility technologies.

2. Theoretical review

2.1. Sustainable urban mobility theory (SUMT)

Sustainable Urban Mobility Theory (SUMT) explains how transport systems can meet mobility needs while reducing environmental harm and improving social equity (Foltýnová et al., 2020). Consistent with Banister's (2008) sustainable mobility paradigm, the theory shifts transport planning away from road expansion and traffic speed toward accessibility, efficiency, liveability, and inclusion. Hartl et al. (2024) state that it emphasises public transport, walking, and cycling while reducing dependence on private vehicles. This approach is particularly relevant in developing cities, where rapid urban growth often produces congestion, air pollution, and unequal access to transport services.

Within this framework, smart mobility is seen as a supporting tool rather than a solution in itself. Digital technologies can improve existing transport systems by enhancing information flow, service reliability, and system coordination. For example, real-time passenger information and integrated ticketing can improve the attractiveness of public transport without major infrastructure expansion. In this study, Sustainable Urban Mobility Theory helps frame smart mobility strategies as planning interventions that must support broader sustainability goals rather than stand-alone technological upgrades.

2.2. Socio-technical systems theory

According to Münch et al. (2022), Socio-Technical Systems Theory explains how technological change depends on the interaction between technical systems and social structures such as institutions, regulations, and user behaviour. In transport systems, this means that governance arrangements, market structures, and public acceptance shape technologies such as intelligent transport systems or mobility platforms. The theory highlights that innovation often fails when technical solutions are introduced without considering the institutional and social environment in which they operate.

This perspective is highly relevant to smart mobility in developing cities. Many cities face challenges such as fragmented transport authorities, weak regulatory frameworks, and limited technical capacity, which can prevent smart mobility initiatives from scaling beyond pilot projects (Das, 2025; Stephen et al., 2025). Socio-Technical Systems Theory supports exploring strategies that strengthen coordination, build institutional capacity, and align technology with existing transport practices. In this study, the theory informs the analysis of smart mobility as a system-level transformation rather than a purely technological change.

2.3. Urban resilience theory

Urban Resilience Theory focuses on the ability of urban systems to cope with shocks, adapt to change, and continue providing essential services under stress (Romero-Lankao et al., 2016; Kong et al., 2022). In transport planning, resilience relates to how mobility systems respond to disruptions such as climate events, infrastructure failures, economic shocks, and rapid changes in travel demand. A resilient transport system is flexible, reliable, and able to maintain access for different social groups over time.

Smart mobility technologies are often associated with resilience because they support real-time monitoring, faster responses to disruptions, and adaptive system management (Okoro & Lawani, 2022; Li et al., 2023; Mutambik, 2025). However, the benefits of resilience depend on how these technologies are governed and integrated into planning processes. In developing cities, social resilience is closely tied to affordability, accessibility, and service reliability, especially for low-income users who depend on public and informal transport. Urban Resilience Theory, therefore, supports the study's focus on strategies that enhance both system adaptability and social inclusion through smart mobility.

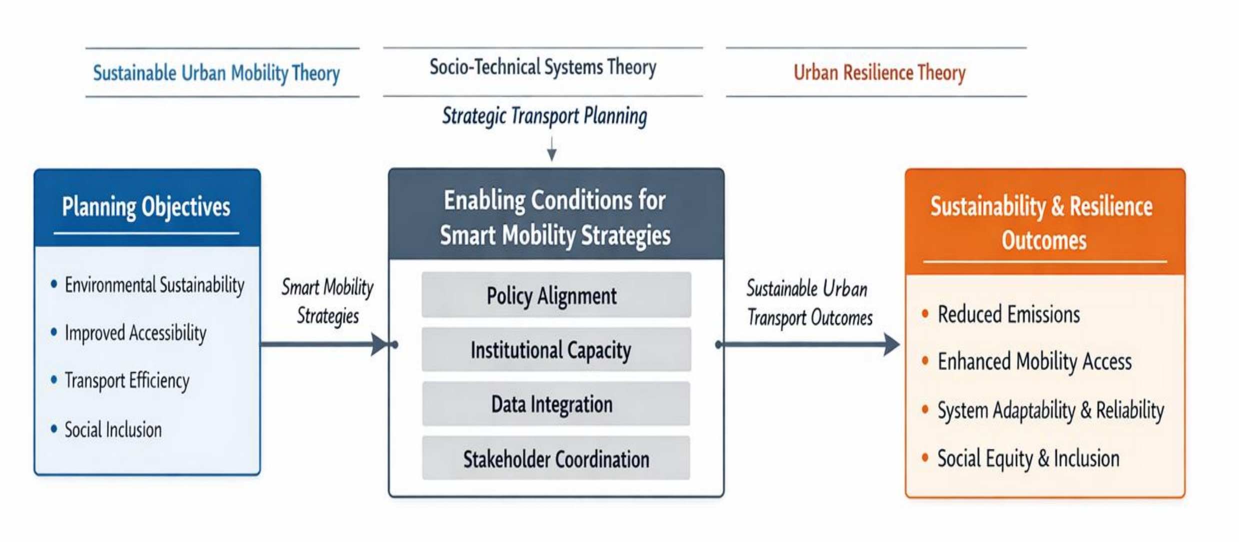
2.4. Strategic transport planning and institutional capacity

Strategic Transport Planning theory emphasises long-term, coordinated decision-making that aligns transport policy, infrastructure investment, and system management with wider urban goals (Löfgren et al., 2018). It contrasts with short-term, project-driven planning, which often produces fragmented outcomes in developing contexts. Strategic planning recognises institutions as central actors in selecting, funding, and implementing transport technologies. Marsden and Reardon (2017) further show that transport policy outcomes depend on governance processes, institutional relationships, and the distribution of decision-making authority. Institutional capacity is therefore central to smart mobility because effective organisations must manage data, coordinate agencies, regulate new mobility services, and integrate them with public transport systems (Okolo et al., 2022; Bellini et al., 2024). Where such capacity is weak, initiatives may remain isolated, poorly maintained, or misaligned with sustainability objectives. In this study, Strategic Transport Planning theory provides the basis for examining governance, coordination, and evidence-based decision-making as conditions for advancing smart mobility.

2.5. Mapping the theoretical framework to the conceptual framework

Figure 1 presents the conceptual framework developed for this study based on the integrated theoretical perspectives discussed in previous sections. The framework positions smart mobility as a planning-led process aimed at achieving sustainable urban transportation outcomes rather than as a stand-alone technological solution. Drawing from Sustainable Urban Mobility Theory, the framework identifies key sustainability objectives, including reduced environmental impact, improved accessibility, enhanced system efficiency, and greater social inclusion, as the intended outcomes of smart mobility strategies. These outcomes guide strategic interventions and reflect broader urban transport planning goals. Socio-Technical Systems Theory informs the framework's structure by emphasising the interaction between smart mobility technologies and institutional conditions, such as policy alignment, data integration, stakeholder coordination, and user acceptance. In Figure 1, these factors are represented as mediating elements that shape how smart mobility strategies influence sustainability outcomes, highlighting the role of governance and system integration in determining effectiveness.

Figure 1: Conceptual framework for exploring strategies to advance smart mobility for sustainable urban transportation



Urban Resilience Theory and Strategic Transport Planning theory further shape the relationships depicted in the framework. Sassaron et al. (2025) state that resilience-related constructs, such as system adaptability, reliability, and responsiveness, capture the urban transport system's capacity to manage disruptions and change while maintaining essential mobility services. These constructs reinforce long-term sustainability by strengthening system performance under uncertainty. Furthermore, Strategic Transport Planning theory provides the overarching structure that links planning objectives, institutional capacity, and technological systems through coordinated, evidence-based decision-making (Löfgren et al., 2018; Bellini et al., 2024). Furthermore, strategic planning shapes smart mobility strategies and links them to sustainability and resilience outcomes, underscoring institutions' central role in translating technological potential into practical transport improvements. Together, these elements illustrate that advancing smart mobility in developing urban contexts requires integrated strategies that align technology with planning, governance, and system capacity to support sustainable urban transportation.

3. Research methods

3.1. Research approach and design

This study adopts a quantitative research approach to explore strategies for advancing smart mobility in South Africa in support of sustainable urban transportation. As Doumard et al. (2023) stated, a quantitative approach is appropriate where the objective is to systematically capture stakeholder assessments, identify dominant strategic priorities, and examine relationships among planning, technology, and institutional factors using standardised instruments. Building on previous transport-related studies by Wang et al. (2023) and Rana & Sadiq (2024), this study employs a cross-sectional survey design, collecting data at a single point in time to reflect current conditions, experiences, and strategic perceptions within the urban transport system. Cross-sectional designs are widely used in transport planning and sustainability research, particularly when the focus is on evaluating current system readiness, policy alignment, or strategic directions rather than long-term behavioural change.

As Fallde & Eklund (2015) explained, theoretical perspectives inform research designs for sustainable urban mobility, socio-technical systems, and strategic transport planning. These perspectives emphasise that smart mobility outcomes depend not only on technological innovation but also on planning frameworks, institutional capacity, governance coordination, and user acceptance. These theories guided the development of the study's conceptual framework and the identification of strategy-related constructs included in the questionnaire. The approach ensures consistency between the study's strategic focus and its empirical measurement, which is essential for producing policy-relevant findings in transport planning research.

3.2. Study area

The study was conducted in South Africa, a developing country characterised by rapid urban growth, heavy reliance on road-based transport, and persistent inequalities in access to mobility. Private vehicle use, minibus taxi services, commuter rail, bus rapid transit systems, and emerging smart mobility initiatives such as digital ticketing, mobility platforms, and data-driven traffic management systems shape urban transport in South Africa. These features create a complex planning environment in which the potential of smart mobility must be reconciled with institutional fragmentation, uneven infrastructure quality, and constrained public-sector capacity.

This study treats South Africa not as a narrow local case but as an analytically representative developing urban context. The challenges it faces are comparable to those in many cities across Africa, Asia, and Latin America, where sustainability goals coexist with limited fiscal resources, the dominance of informal transport, and uneven technological readiness. Examining strategic approaches to advancing smart mobility in this context provides insights relevant beyond national boundaries. It contributes to broader discussions on how developing cities can align smart mobility initiatives with sustainable transport objectives.

3.3. Survey instrument and data collection

3.3.1. Questionnaire design and content

The study collected primary data using a structured questionnaire. The questionnaire was specifically designed to capture stakeholder perspectives on strategic actions, policy directions, and system-level interventions required to support smart mobility implementation. It consisted of two main sections. Section A collected demographic and professional information, including respondent role within the transport system, employment sector, educational qualification, and years of experience. These variables support sample characterisation and enable comparison of strategic priorities across stakeholder groups.

Section B focused on strategy-oriented variables related to advancing smart mobility. Items were developed from a literature review on smart mobility planning, sustainable transport policy, and urban governance. The first group of items addressed institutional coordination, policy alignment, and capacity building. A second group examined data integration, infrastructure readiness, user engagement, and integrating smart mobility with public transport systems. This organisation moved the questionnaire beyond general perceptions and allowed it to capture actionable strategies relevant to transport planning and technology implementation.

As Yaska & Nuhu (2024) suggested, all items in Section B were measured using a five-point Likert scale ranging from strong disagreement to strong agreement. This scale allows respondents to express varying degrees of support for different strategies while enabling robust statistical analysis. The questionnaire was kept clear and non-technical to ensure accessibility to respondents with diverse professional and educational backgrounds.

3.3.2. Sampling strategy and stakeholder representation

Following Chindasombatcharoen et al. (2024), the study adopted a multi-stakeholder sampling strategy to reflect the diversity of actors involved in urban transport planning, operation, and use. Respondents included public transport users, private road users, rail transport users, logistics and freight operators, transport infrastructure professionals, policy and regulatory officials, and smart mobility service providers. This approach recognises that strategies for advancing smart mobility must account for both user-level experiences and system-level decision-making processes. Respondents were recruited through professional networks, transport-related institutions, and targeted outreach within the transport, logistics, policy, and technology sectors.

3.3.3. Data collection procedure and ethics

Data collection was conducted online using Google Forms. Online administration enabled broad geographic reach and efficient engagement with diverse respondent groups, a practice increasingly used in transport and planning research. The authors obtained ethical approval from their institutional ethics committee before data collection. Participation was voluntary; respondents were informed of the study's purpose, no personally identifiable information was collected, and all responses were treated confidentially.

3.4. Respondent profile

The respondent profile reflects a diverse cross-section of actors in South Africa's urban transport system, supporting the study's strategic orientation. Of the 201 questionnaires retrieved, public transport users represent the largest group (39.3%, n = 79), followed by private road users (33.8%, n = 68), accounting for over 73% of the sample. These groups offer insights into user-facing challenges and priorities critical to shaping smart mobility strategies. Logistics, freight, and supply chain operators account for 9.0 per cent (n = 18), while rail users and transport infrastructure professionals each represent 6.5 per cent (n = 13). Policy and regulatory officials and smart mobility service providers each constitute 2.5 per cent (n = 5), offering governance and implementation perspectives that, although numerically smaller, are strategically important.

Respondents also demonstrate substantial professional experience within the transport sector. The majority have 6-10 years of experience (42.3%, n = 85), followed by those with 1–5 years (32.8%, n = 66). More experienced respondents with over 10 years in the sector provide additional depth, contributing insights shaped by long-term exposure to transport policy evolution and system change. Educational qualifications range from diplomas to doctoral degrees, indicating a balance between technical expertise and advanced analytical capacity. The employment sector distribution also shows strong private-sector representation, complemented by participants from academia, public institutions, and students, reinforcing the data's relevance to real-world transport strategy development.

3.5. Data analysis

As Ramdani (2025) stated, the study used descriptive and inferential statistical techniques. Descriptive statistics, including frequencies and percentages, summarised respondent characteristics and stakeholder distribution. For strategy-related items measured on a Likert scale, mean item scores were calculated to rank the proposed smart mobility strategies by perceived importance and feasibility. Standard deviation values were used to assess the degree of consensus among respondents. This approach is commonly applied in transport planning studies to support prioritisation of strategic interventions.

To examine possible underlying strategic patterns, we conducted exploratory principal component analysis using direct oblimin rotation with Kaiser normalisation. The analysis included 201 cases and 14 strategy items, giving a case-to-item ratio of approximately 14.4:1. Although this ratio is numerically adequate for exploratory analysis, it does not override the weak inter-item correlations indicated by the KMO and Bartlett diagnostics. We assessed sampling suitability using the Kaiser-Meyer-Olkin measure, Bartlett's test of sphericity, communalities, eigenvalues, and cumulative explained variance, following the cautions outlined by Field et al. (2012). Because the observed KMO value was only marginal and Bartlett's test did not reach the conventional 0.05 level, the analysis was used for pattern exploration rather than construct validation. Component labels are therefore presented as tentative interpretive groupings and not as a confirmed measurement structure. All analyses were performed using SPSS.

The sample composition also constrained stakeholder-group comparisons. Public and private transport users represented more than 73 per cent of respondents, whereas policy officials and smart mobility service providers each numbered only five. Inferential comparison of rankings across these groups would therefore produce unstable estimates and potentially misleading conclusions. The descriptive rankings are consequently interpreted as aggregate sample perceptions, not as evidence that all stakeholder categories hold identical priorities. Future studies should use stratified sampling with adequate numbers of officials, operators, providers, and users to test convergence or divergence across groups.

4. Results

4.1. Descriptive

Table 1 presents the aggregate ranking of strategies for advancing smart mobility. Investment in digital and ICT infrastructure ranks first (mean = 4.43; SD = 0.785), followed by cybersecurity frameworks (mean = 4.36; SD = 0.807). Smart mobility policy formulation and enforcement (mean = 4.31) and unified data standards (mean = 4.30) also receive strong support, indicating the perceived importance of institutional alignment and interoperability. Service expansion, AI and big data use, and capacity building rank in the middle and show somewhat greater variability. Behaviour change, public awareness, and electric vehicle infrastructure rank lower, although their mean scores still indicate broad support. Mean scores varied by only 0.26 points across all 14 items, from 4.17 to 4.43, and the standard deviations overlapped. A Friedman test was not conducted because the analysis was specified as an exploratory descriptive ranking rather than an inferential comparison of within-respondent item distributions. Accordingly, the rank order is used only as a compact summary of aggregate responses and does not establish statistically distinct priorities or differences beyond sampling noise. Because transport users account for most respondents, do not treat the rankings as proof of consensus among policy officials, operators, and users.

Table 1: Descriptive ranking of smart mobility advancement strategies

Strategies	Mean	Std. Deviation	Rank
Investment in digital and ICT infrastructure to support connected transport systems	4.43	0.785	1
Strengthening cybersecurity frameworks to protect transport data and digital platforms	4.36	0.807	2
Formulation and enforcement of smart mobility policies and digital mobility regulations	4.31	0.886	3
Establishment of unified data standards to enable interoperability across mobility platforms	4.30	0.866	4
Collaboration and knowledge-sharing between public agencies, private firms, and digital innovators	4.30	0.895	5
Expansion of smart mobility service offerings (e-hailing and a single platform)	4.29	0.818	6
Use of AI, IoT, and big data analytics to optimise mobility planning and traffic management	4.27	0.937	7
Capacity building and skills development for smart mobility planning and system operations	4.26	0.850	8
Behaviour change programmes targeting commuters and operators for digital adoption readiness	4.23	0.933	9
Government incentives and funding support for transport digitalisation initiatives	4.22	0.886	10
Public awareness and digital literacy programmes to encourage the adoption of smart mobility services	4.22	0.907	11
Integration of transport modes into a single platform (MaaS) to promote seamless mobility experiences	4.18	0.917	12
Development of robust EV charging networks and incentives for electric vehicle adoption	4.17	1.006	13
Promotion of innovation ecosystems, research, and pilot projects for emerging mobility solutions	4.17	1.017	14

4.2. Exploratory factor analysis

The suitability tests in Table 2 provide limited support for factor analysis. The KMO value of 0.501 sits at the lower boundary commonly considered for exploratory work and indicates marginal sampling adequacy. Bartlett's test of sphericity yielded an approximate chi-square value of 111.845 with 91 degrees of freedom and $p = 0.068$, which is above the conventional 0.05 significance threshold. The null hypothesis that the correlation matrix is an identity matrix therefore cannot be rejected at the 5 per cent level. These diagnostics do not support presenting the resulting components as a stable latent structure. The analysis is retained only as an exploratory, pattern-seeking exercise, and the component solution should be regarded as provisional pending replication with a stronger correlation structure and a more balanced sample.

Table 2: KMO and Bartlett's test results for smart mobility strategy factors

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.501
Bartlett's Test of Sphericity	Approx. Chi-Square	111.845
	df	91
	Sig.	0.068

Table 3 shows substantial variation in the proportion of each strategy explained by the retained components. Expansion of smart mobility service offerings has the highest extraction communality (0.540), followed by innovation ecosystems and pilot projects (0.401), public awareness and digital literacy (0.375), and cybersecurity frameworks (0.343). Several items are weakly represented, including unified data standards (0.127), electric vehicle charging networks and incentives (0.206), behaviour change programmes (0.221), and digital and ICT infrastructure (0.241). These low communalities indicate that much of the variance in several strategically important items remains unexplained. The component interpretation therefore rests more strongly on a limited subset of items and should not be generalised as a comprehensive structure of smart mobility strategy.

Table 3: Communalities of smart mobility strategy variables

Communalities	Initial	Extraction
Investment in digital and ICT infrastructure to support connected transport systems	1.000	0.241
Expansion of smart mobility service offerings (e-hailing and a single platform)	1.000	0.540
Development of robust EV charging networks and incentives for electric vehicle adoption	1.000	0.206
Establishment of unified data standards to enable interoperability across mobility platforms	1.000	0.127
Integration of transport modes into a single platform (MaaS) to promote seamless mobility experiences	1.000	0.280
Strengthening cybersecurity frameworks to protect transport data and digital platforms	1.000	0.343
Formulation and enforcement of smart mobility policies and digital mobility regulations	1.000	0.315
Government incentives and funding support for transport digitalisation initiatives	1.000	0.320
Public awareness and digital literacy programmes to encourage the adoption of smart mobility services	1.000	0.375
Behaviour change programmes targeting commuters and operators for digital adoption readiness	1.000	0.221
Collaboration and knowledge-sharing between public agencies, private firms, and digital innovators	1.000	0.262
Promotion of innovation ecosystems, research, and pilot projects for emerging mobility solutions	1.000	0.401
Capacity building and skills development for smart mobility planning and system operations	1.000	0.300
Use of AI, IoT, and big data analytics to optimise mobility planning and traffic management	1.000	0.262

Note: Extraction Method: Principal Component Analysis.

Table 4 reports the total variance explained by the principal component analysis. The reported extraction retained three components, which respectively explain 10.64 per cent, 10.39 per cent, and 8.92 per cent of the variance, for a cumulative total of 29.95 per cent. This leaves more than 70 per cent of the item variance outside the retained solution. In addition, Components 4 to 8 also have eigenvalues above 1.0, so the Kaiser criterion alone does not uniquely justify a three-component solution. The retained structure is therefore treated as a parsimonious working interpretation based on the reported extraction and substantive coherence, rather than a definitive factor solution. Future work should apply Horn's parallel analysis to compare observed eigenvalues with eigenvalues generated from random data, identifying how many components exceed chance expectations before testing any retained structure in an independent sample.

Table 4: Total variance explained by extracted components

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	1.489	10.636	10.636	1.489	10.636	10.636
2	1.454	10.386	21.022	1.454	10.386	21.022
3	1.249	8.924	29.946	1.249	8.924	29.946
4	1.154	8.246	38.192			
5	1.113	7.948	46.140			
6	1.078	7.699	53.839			
7	1.033	7.382	61.221			
8	1.014	7.241	68.462			
9	.919	6.562	75.023			
10	.829	5.924	80.947			
11	.807	5.764	86.712			
12	.692	4.943	91.655			
13	.649	4.636	96.291			
14	.519	3.709	100.000			

Table 5 presents the component matrix from the principal component analysis, showing the loadings of smart mobility strategy variables across the three extracted components. The results indicate a differentiated structure in which strategy variables cluster around distinct underlying dimensions. Component 1 is primarily associated with system enablement and innovation-oriented strategies, with relatively strong positive loadings observed for promotion of innovation ecosystems and pilot projects (0.565), investment in digital and ICT infrastructure (0.480), development of EV charging networks and incentives (0.443), strengthening cybersecurity frameworks (0.436), and formulation of smart mobility policies and regulations (0.425). This component reflects a strategic focus on building the technological and regulatory foundations required to support smart mobility advancement. Component 2 is characterised by strategies related to service expansion and institutional capacity, with high loadings for expanding smart mobility service offerings (0.621), capacity building and skills development (0.518), public awareness and digital literacy programmes (0.394), and government incentives and funding support (0.384). These loadings suggest a dimension centred on enabling adoption through services, skills, and supportive policy instruments.

Component 3 captures collaboration, integration, and behavioural change dynamics, with notable loadings for collaboration and knowledge-sharing among public and private actors (0.488), government incentives and funding support (0.413), and negative loadings for integration of transport modes into a single platform (-0.512) and behaviour change programmes (-0.462). The presence of both positive and negative loadings indicates contrasting strategic emphases within this component, highlighting tensions between system integration efforts and user adaptation challenges. Overall, the component structure suggests that strategies to advance smart mobility in South Africa are organised around multiple interrelated yet distinct dimensions, reinforcing the need for coordinated, balanced policy approaches rather than reliance on a single strategic pathway.

Table 6 shows the exploratory factor analysis, interpreted using the structure matrix from oblique rotation, which identified three distinct components representing different strategic dimensions for advancing smart mobility in South Africa. Interpretation is based on the magnitude and direction of correlations between variables and components, with emphasis on variables that show relatively stronger associations within each component. Variables with weak correlations are reported but not treated as defining components.

Table 5: Component loadings for smart mobility strategy variables

Component matrix [a]	Component		
	1	2	3
Investment in digital and ICT infrastructure to support connected transport systems	0.480	-0.061	0.088
Expansion of smart mobility service offerings (e-hailing and a single platform)	0.335	0.621	0.203
Development of robust EV charging networks and incentives for electric vehicle adoption	0.443	-0.001	-0.095
Establishment of unified data standards to enable interoperability across mobility platforms	0.181	0.247	0.181
Integration of transport modes into a single platform (MaaS) to promote seamless mobility experiences	0.051	0.122	-0.512
Strengthening cybersecurity frameworks to protect transport data and digital platforms	0.436	-0.206	-0.333
Formulation and enforcement of smart mobility policies and digital mobility regulations	0.425	0.360	0.068
Government incentives and funding support for transport digitalisation initiatives	-0.043	0.384	0.413
Public awareness and digital literacy programmes to encourage the adoption of smart mobility services	-0.467	0.394	0.030
Behaviour change programmes targeting commuters and operators for digital adoption readiness	-0.004	0.085	-0.462
Collaboration and knowledge-sharing between public agencies, private firms, and digital innovators	-0.052	-0.147	0.488
Promotion of innovation ecosystems, research, and pilot projects for emerging mobility solutions	0.565	-0.219	0.184
Capacity building and skills development for smart mobility planning and system operations	0.047	0.518	-0.174
Use of AI, IoT, and big data analytics to optimise mobility planning and traffic management	0.001	-0.410	0.306

Extraction Method: Principal Component Analysis.a
[a]. 3 components extracted.

Component 1 (***Smart Mobility Infrastructure Enablement***) is primarily defined by investment in digital and ICT infrastructure to support connected transport systems (0.461) and the development of robust EV charging networks and incentives for electric vehicle adoption (0.417). These correlations indicate that this component represents a foundational infrastructure strategy focused on enabling smart mobility through core digital and low-emission transport assets. Other variables within this component, including expansion of smart mobility service offerings (0.066) and establishment of unified data standards (0.063), exhibit very weak associations and therefore do not meaningfully contribute to interpreting this component. Overall, Component 1 reflects a strategic emphasis on the readiness of physical and digital infrastructure as a necessary baseline for advancing smart mobility.

Component 2 (***Policy, Regulatory, and Institutional Support***) is dominated by governance- and policy-related strategies. Strong correlations are observed for the formulation and enforcement of smart mobility policies and digital mobility regulations (0.495) and government incentives and funding support for transport digitalisation initiatives (0.451), clearly identifying this component as an institutional and regulatory support dimension. Public awareness and digital literacy programmes show a weak positive correlation (0.175), while integration of transport modes into a single platform (-0.041), strengthening cybersecurity frameworks (-0.122), and behaviour change programmes (-0.077) exhibit weak negative correlations. These weak associations suggest that while such strategies are present in the dataset, they are not central to the defining structure of this component. Component 2, therefore, captures the role of formal policy instruments and financial mechanisms in shaping smart mobility implementation.

Component 3 ***(Collaborative and Data-Driven Mobility Innovation)*** reflects a collaboration- and technology-oriented pattern. Collaboration and knowledge-sharing between public agencies, private firms, and digital innovators has the strongest correlation with this component (0.511), followed by the use of AI, IoT, and big data analytics (0.424). Capacity building and skills development has a moderate negative loading (-0.340), while innovation ecosystems and pilot projects show a weak positive loading (0.208). The negative sign identifies a contrast in the rotated response pattern, but factor-loading signs are orientation-dependent and do not establish a substantive or causal disconnect. Any suggestion that advanced innovation is insufficiently aligned with human capacity should therefore be treated as a post-hoc hypothesis for further investigation, not as a confirmed empirical finding.

The three-component solution provides a tentative way to organise the reported strategy items around infrastructure readiness, policy and institutional support, and collaborative data-driven innovation. However, the marginal KMO value, non-significant Bartlett result, low communalities, competing eigenvalues, and low cumulative explained variance limit confidence in this structure. The components are therefore used as provisional interpretive categories that help organise discussion, while the descriptive rankings remain the stronger empirical basis for the study's conclusions.

Table 6: Structure matrix of smart mobility strategy components

Structure matrix	Component		
	1	2	3
Investment in digital and ICT infrastructure to support connected transport systems	0.461		
Expansion of smart mobility service offerings (e-hailing and a single platform)	0.066		
Development of robust EV charging networks and incentives for electric vehicle adoption	0.417		
Establishment of unified data standards to enable interoperability across mobility platforms	0.063		
Integration of transport modes into a single platform (MaaS) to promote seamless mobility experiences		-0.041	
Strengthening cybersecurity frameworks to protect transport data and digital platforms		-0.122	
Formulation and enforcement of smart mobility policies and digital mobility regulations		0.495	
Government incentives and funding support for transport digitalisation initiatives		0.451	
Public awareness and digital literacy programmes to encourage the adoption of smart mobility services		0.175	
Behaviour change programmes targeting commuters and operators for digital adoption readiness		-0.077	
Collaboration and knowledge-sharing between public agencies, private firms, and digital innovators			0.511
Promotion of innovation ecosystems, research, and pilot projects for emerging mobility solutions			0.208
Capacity building and skills development for smart mobility planning and system operations			-0.340
Use of AI, IoT, and big data analytics to optimise mobility planning and traffic management			0.424

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalisation.

5. Discussion

The descriptive results position smart mobility primarily as a system-capacity issue. Digital and ICT infrastructure, cybersecurity, policy enforcement, and data standards received the highest aggregate rankings. This pattern is consistent with sustainable mobility research that treats reliable infrastructure, information systems, and clear rules as conditions for changes in accessibility and system performance (Ketter et al., 2023; Rui & Othengrafen, 2023). For developing cities, this implies that technology deployment should align with the capacity of the institutions and networks expected to support it. The aggregate pattern is persuasive, although the user-heavy sample means it should not be interpreted as demonstrated agreement across every stakeholder group.

Strong support for regulation and data governance also frames smart mobility as a governance concern. The high rankings for policy formulation, enforcement, and unified data standards accord with socio-technical perspectives in which technologies stabilise through rules, norms, and shared standards (Choenni et al., 2022; Anthony Jnr, 2025). Marsden and Reardon (2017) similarly argue that transport policy analysis must account for institutional relationships and decision-making processes. In developing cities, fragmented mandates across transport, ICT, and planning agencies can obstruct integration (Das, 2025; Stephen et al., 2025). The provisional policy and institutional component is consistent with this argument, but the weak factor diagnostics mean that the descriptive rankings, rather than the component label alone, provide the firmer basis for policy interpretation.

The provisional collaborative and data-driven innovation component links multi-actor collaboration with AI, IoT, and big data analytics. This relationship is consistent with evidence that shared data and collaborative governance can improve service coordination and planning (Visan et al., 2022; Attah et al., 2024). Capacity building loaded negatively on the same rotated component, but the sign is orientation-dependent, and the weak solution does not support a substantive interpretation. No conclusion about alignment between technological ambition and organisational learning is drawn from this loading.

Behaviour change programmes, public awareness initiatives, and electric vehicle charging investments received slightly lower rankings than digital infrastructure, cybersecurity, and regulation. A non-peer-reviewed preprint by Kangralkar et al. (2025) offers supporting discussion of cybersecurity and stakeholder requirements for electric mobility, but its evidence is treated cautiously. The ranking pattern suggests a possible sequencing preference in which foundational systems precede user-facing measures. It does not imply that behaviour change, inclusion, or electrification can be deferred indefinitely. Sustainable mobility depends on introducing these measures promptly once minimum institutional and digital conditions are in place (Creutzig et al., 2016; Rahman, 2025).

The findings support a provisional capacity-first sequencing proposition. Stage 1 centres on secure digital infrastructure, data governance, regulatory clarity, and defined institutional responsibilities. Stage 2 connects these foundations to workforce development, interagency coordination, and interoperable public transport systems. Stage 3 scales advanced analytics, integrated mobility platforms, electric mobility, and behaviour-change programmes while monitoring accessibility, emissions, reliability, and inclusion. This proposition extends socio-technical and strategic transport planning perspectives by treating institutional readiness as a gating condition rather than a parallel input. It is testable: future studies can examine whether the effects of user-facing smart mobility interventions on accessibility and emissions become stronger after defined capacity thresholds are reached.

6. Conclusion

This study examined how urban transport policy can align smart mobility initiatives with planning and institutional capacity in developing cities. The aggregate South African mean-score rankings placed digital and ICT infrastructure, cybersecurity, regulatory frameworks, and data standards above Mobility-as-a-Service integration, electric vehicle incentives, and behaviour-change programmes. However, the narrow score range does not establish statistically distinct priorities. The descriptive rankings provide the strongest evidence for a capacity-first interpretation. The three reported components offer only a tentative organising structure because they explain 29.95 per cent of variance and are supported by marginal factorability diagnostics.

Based solely on the aggregate descriptive rankings, the study proposes for future testing that institutional readiness may operate as a gating condition for smart mobility adoption. Practically, the capacity-first sequence directs policymakers to secure digital infrastructure, data governance, regulation, coordination, and skills before scaling integrated platforms and advanced analytics. These priorities can contribute to SDG 9 through resilient infrastructure, SDG 11 through accessible and sustainable urban mobility, and SDG 13 through transport-related emissions reduction. The sequence remains a proposition to be tested rather than a causal model confirmed by the present cross-sectional data.

The study is limited by its cross-sectional design, single-country scope, and reliance on stakeholder perceptions. The sample is heavily weighted toward public and private transport users, while policy officials and smart mobility service providers each account for only five respondents. This imbalance prevented statistically reliable subgroup comparisons, and limits claims about institutional consensus. The marginal KMO value, Bartlett's test result above 0.05, low communalities, competing eigenvalues, and cumulative explained variance below 30 per cent further mean that the three-component solution should be treated as emerging rather than confirmed.

Future research should test the proposed sequencing logic longitudinally and across several developing-country contexts. Stratified samples should include enough users, operators, officials, infrastructure professionals, and technology providers to compare priorities reliably. Horn's parallel analysis should compare observed eigenvalues with random-data eigenvalues before using alternative extraction methods and confirmatory factor analysis on an independent sample to assess whether the proposed dimensions are reproducible. Qualitative interviews and organisational capacity measures can test the explicit hypothesis that technological ambition outpaces organisational learning in some institutions; the present loading pattern neither supports nor rejects this hypothesis. Outcome-based studies can test whether institutional readiness strengthens the effects of smart mobility interventions on accessibility, service reliability, inclusion, and emissions.

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The Faculty Ethics and Plagiarism Committee (FEPC) at the University of Johannesburg (UJ) granted permission to conduct the study (approval number UJ-FEBE-FEPC-01806).

Data availability statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

AI Usage Declaration

The preparation and revision of this manuscript were supported by OpenAI's ChatGPT and Google's Gemini for conceptual clarification, structuring, and language editing, while Grammarly was used for proofreading. The authors independently reviewed the statistical interpretation, verified the cited evidence, approved all revisions, and retain full responsibility for the manuscript's analysis, synthesis, and conclusions.

Conflicts of Interest

The authors declare no conflict of interest.

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References

Aboulnaga, M. M., Badran, M. F., & Barakat, M. M. (2021). Global informal settlements and urban slums in cities and the coverage. In *resilience of informal areas in megacities–magnitude, challenges, and policies: Strategic environmental assessment and upgrading guidelines to attain sustainable development goals* (pp. 1-51). Springer International Publishing, Cham. https://doi.org/10.1007/978-3-030-87794-1_1

Anthony Jnr, B. (2025). Sustainable mobility governance in smart cities for urban policy development–a scoping review and conceptual model. *Smart and sustainable built environment*, *14*(3), 649-671. https://doi.org/10.1108/SASBE-05-2023-0109

Attah, R. U., Gil-Ozoudeh, I., Garba, B. M. P., & Iwuanyanwu, O. (2024). Leveraging geographic information systems and data analytics for enhanced public sector decision-making and urban planning. *Magna Sci Adv Res Rev*, *12*(2), 152-163. https://doi.org/10.30574/msarr.2024.12.2.0191

Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, 15(2), 73-80. https://doi.org/10.1016/j.tranpol.2007.10.005

Bellini, P., Bilotta, S., Collini, E., Fanfani, M., & Nesi, P. (2024). Data sources and models for integrated mobility and transport solutions. *Sensors*, *24*(2), 1-22. https://doi.org/10.3390/s24020441

Chindasombatcharoen, N., Tsolakis, N., Kumar, M., & O'Sullivan, E. (2024). Navigating psychological barriers in agricultural innovation adoption: A multi-stakeholder perspective. *Journal of Cleaner Production*, *475*, 1-14. https://doi.org/10.1016/j.jclepro.2024.143695

Choenni, S., Bargh, M. S., Busker, T., & Netten, N. (2022). Data governance in smart cities: Challenges and solution directions. *Journal of Smart Cities and Society*, *1*(1), 31-51. https://doi.org/10.3233/SCS-210119

Chovancová, J., Popovičová, M., & Huttmanová, E. (2023). Decoupling transport-related greenhouse gas emissions and economic growth in the European Union countries. *Journal of Sustainable Development of Energy, Water and Environment Systems*, *11*(1), 1-18. https://doi.org/10.13044/j.sdewes.d9.0411

Creutzig, F., Fernandez, B., Haberl, H., Khosla, R., Mulugetta, Y., & Seto, K. C. (2016). Beyond technology: demand-side solutions for climate change mitigation. *Annual Review of Environment and Resources*, *41*(1), 173-198. https://doi.org/10.1146/annurev-environ-110615-085428

Das, D. K. (2025). Digital technology and AI for smart sustainable cities in the global south: A critical review of literature and case studies. *Urban Science*, *9*(3), 1-32. https://doi.org/10.3390/urbansci9030072

Deweerdt, T., & Fabre, A. (2022). The role of land use planning in urban transport to mitigate climate change: A literature review. *Advances in Environmental and Engineering Research*, *3*(3), 1-22. https://doi.org/10.21926/aeer.2203033

Doumard, E., Aligon, J., Escriva, E., Excoffier, J. B., Monsarrat, P., & Soulé-Dupuy, C. (2023). A quantitative approach for the comparison of additive local explanation methods. *Information Systems*, *114*, 1-18. https://doi.org/10.1016/j.is.2022.102162

Fallde, M., & Eklund, M. (2015). Towards a sustainable socio-technical system of biogas for transport: The case of the city of Linköping in Sweden. *Journal of Cleaner production*, *98*, 17-28. https://doi.org/10.1016/j.jclepro.2014.05.089

Field, A., Miles, J., & Field, Z. (2012). *Discovering Statistics Using R*. SAGE Publications.

Foltýnová, H. B., Vejchodská, E., Rybová, K., & Květoň, V. (2020). Sustainable urban mobility: One definition, different stakeholders' opinions. *Transportation research part D: Transport and environment*, *87*, 1-14. https://doi.org/10.1016/j.trd.2020.102465

Hartl, R., Harms, P., & Egermann, M. (2024). Towards transformation-oriented planning: What can sustainable urban mobility planning (SUMP) learn from transition management (TM)? *Transport Reviews*, *44*(1), 167-190. https://doi.org/10.1080/01441647.2023.2239497

Kangralkar, Y. M., Bavalatti, S. I., & Pattar, S. (2025). A comprehensive survey on cybersecurity of EV: Roles and requirements of stakeholders, gaps and an exemplar future direction [Preprint]. Retrieved from https://d197for5662m48.cloudfront.net/documents/publicationstatus/258472/preprint_pdf/0a6d1db1ae97aa27b60b7ab2c019a02d.pdf

Ketter, W., Schroer, K., & Valogianni, K. (2023). Information systems research for smart sustainable mobility: A framework and call for action. *Information Systems Research*, *34*(3), 1045-1065. https://doi.org/10.1287/isre.2022.1167

Kong, L., Mu, X., Hu, G., & Zhang, Z. (2022). The application of resilience theory in urban development: A literature review. *Environmental Science and Pollution Research*, *29*(33), 49651-49671. https://doi.org/10.1007/s11356-022-20891-x

Kumbhar, A. A., Alam, M., Memon, T. A., Waseer, B. A., Ali, N., Ahmed, F., & Landini, S. (2025). Socio-techno-economic analysis of hydrogen adoption as a transport sector fuel alternative in Pakistan: An analytic hierarchy process approach. *Policy Research Journal*, *3*(9), 60-80. https://policyrj.com/index.php/1/article/view/970

Li, J., Peng, L., Hou, K., Tian, Y., Ma, Y., Xu, S., & Qiu, T. Z. (2023). Adaptive signal control and coordination for urban traffic control in a connected vehicle environment: A review. *Digital Transportation and Safety*, *2*(2), 89-111. https://doi.org/10.48130/DTS-2023-0008

Löfgren, S., Nilsson, K. L., & Johansson, C. M. (2018). Considering landscape in strategic transport planning. *Transportation Research Part D: Transport and Environment*, *65*, 396-408. https://doi.org/10.1016/j.trd.2018.09.001

Luitel, S., Magar, T. G., Magar, K. B., Subedi, A. K., Adhikari, S., & Nepali, K. (2025a). Shaping sustainable public transport in Nepal: Insights from global developing cities. *International Journal of Future Engineering Innovations*, *2*(4), 148-157. https://doi.org/10.54660/IJMOR.2025.4.4.148-157

Luitel, S., Subedi, A. K., Nepal, S., & Tiwari, H. (2025b). A multi-faceted approach to urban congestion in developing nations: Theory, practice, and the Kathmandu experience. *Journal of Advanced College of Engineering and Management*, 11, 139-163. https://doi.org/10.3126/jacem.v11i1.84536

Mangara, F., & Dorasamy, N. (2026). Policy integration between urban planning and disaster risk reduction in Southern Africa. In *Sustainable Urban Development in Southern Africa: Disaster Risk Reduction and Economic Resilience* (pp. 207-248). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-032-08286-2_9

Marsden, G., & Reardon, L. (2017). Questions of governance: Rethinking the study of transportation policy. *Transportation Research Part A: Policy and Practice*, 101, 238-251. https://doi.org/10.1016/j.tra.2017.05.008

Münch, C., Marx, E., Benz, L., Hartmann, E., & Matzner, M. (2022). Capabilities of digital servitisation: Evidence from the socio-technical systems theory. *Technological Forecasting and Social Change*, *176*, 1-16. https://doi.org/10.1016/j.techfore.2021.121361

Mutambik, I. (2025). IoT-Enabled adaptive traffic management: A multiagent framework for urban mobility optimisation. *Sensors*, *25*(13), 1-30. https://doi.org/10.3390/s25134126

Okolo, F. C., Etukudoh, E. A., Ogunwole, O., Osho, G. O., & Basiru, J. O. (2022). Policy-oriented framework for multi-agency data integration across national transportation and infrastructure systems. *Journal of Frontiers in Multidisciplinary Research,* 3(1), 140-149. https://doi.org/10.54660/.IJFMR.2022.3.1.140-149

Okoro, C. S., & Lawani, K. (2022). Optimising sustainable mobility: A performance assessment of non-motorised transport infrastructure in Johannesburg, South Africa. *Journal of the South African*

Institution of Civil Engineering, *64*(2), 67-76. https://doi.org/10.17159/2309-8775/2022/v64no2a6

Oladimeji, D., Gupta, K., Kose, N. A., Gundogan, K., Ge, L., & Liang, F. (2023). Smart transportation: An overview of technologies and applications. *Sensors*, *23*(8), 1-32. https://doi.org/10.3390/s23083880

Opara, I. J., Lateef, J., Nii-Okai, E., Saah, B. P., Mensah, E. K., Wiafe, G. F. O., & Olayode, A. (2025). Digital resilience in construction projects: A narrative review of data governance, BIM, and real-time decision support systems. *Journal of Management, and Development Research*, *2*(2), 117-124. https://doi.org/10.69739/jmdr.v2i2.1129

Rahman, M. A. (2025). Vehicle-To-Infrastructure (V2I) communication and traffic incident reduction: An empirical study across US highway networks. *Journal of Sustainable Development and Policy*, *4*(03), 38-81. https://doi.org/10.63125/c1wm0t92

Ramdani, F. (2025). Statistics descriptive and inferential. In *Data Science: Foundations and Hands-on Experience: Handling Economic, Spatial, and Multidimensional Data with R* (pp. 115-154). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-96-4683-8_4

Rana, M., & Sadiq, H. (2024). Computational modeling and simulation techniques for managing rail-urban interface constraints in metropolitan transportation systems. *American Journal of Scholarly Research and Innovation*, 3(2), 141-178. https://doi.org/10.63125/pxet1d94

Romero-Lankao, P., Gnatz, D. M., Wilhelmi, O., & Hayden, M. (2016). Urban sustainability and resilience: From theory to practice. *Sustainability*, 8(12), 1-19. https://doi.org/10.3390/su8121224

Rubio, B. M., & Ruiz, S. G. (2025). Unequal access to urban transport: An invisible barrier to social equity: Acceso desigual al transporte urbano: una barrera invisible para la equidad social. *Revista de Justicia Social en la Sociedad Urbana*, *1*(1), 25-60. https://publications.socipol.org/index.php/rjs/article/view/7/12

Rui, J., & Othengrafen, F. (2023). Examining the role of innovative streets in enhancing urban mobility and livability for sustainable urban transition: A review. *Sustainability*, *15*(7), 1-21. https://doi.org/10.3390/su15075709

Sahu, P. K., Pani, A., & Santos, G. (2022). Freight traffic impacts and logistics inefficiencies in India: Policy interventions and solution concepts for sustainable city logistics. *Transportation in Developing Economies*, 8, Article 31. https://doi.org/10.1007/s40890-022-00161-8

Sassaron, M. L. D. S., Rodrigues da Silva, A. N., Fonseca, F., Rodrigues, D., Ribeiro, P. J., & Nakata-Osaki, C. M. (2025). Combining resilience and sustainability in urban mobility: A scoping review and thematic analysis. *Land*, *14*(10), 1-31. https://doi.org/10.3390/land14102063

Stephen, S. S., Oke, A. E., Aigbavboa, C. O., Akinradewo, O. I., Adetoro, P. E., & Ikuabe, M. (2025). Smart Infrastructure and Development in Stealth Construction. In *Stealth Construction: Integrating Practices for Resilience and Sustainability* (pp. 163-193). Emerald Publishing Limited. https://doi.org/10.1108/978-1-83608-182-120251007

Visan, M., Negrea, S. L., & Mone, F. (2022). Towards intelligent public transport systems in smart cities; collaborative decisions to be made. *Procedia Computer Science*, *199*, 1221-1228. https://doi.org/10.1016/j.procs.2022.01.155

Wang, X., Shaw, F. A., Mokhtarian, P. L., Circella, G., & Watkins, K. E. (2023). Combining disparate surveys across time to study satisfaction with life: The effects of study context, sampling method, and transport attributes. *Transportation*, *50*(2), 513-543. https://doi.org/10.1007/s11116-021-10252-x

Widaman, K. F., & Helm, J. L. (2023). Exploratory factor analysis and confirmatory factor analysis. In H. Cooper, M. N. Coutanche, L. M. McMullen, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), In: *APA handbook of research methods in psychology: Data analysis and research publication* (2nd ed., pp. 379–410). American Psychological Association. https://doi.org/10.1037/0000320-017

Xin, S., & Qian, H. (2025). From urban planning to territorial spatial planning: The evolution of china's planning system and the persistent barriers to urban–rural integration. *Land*, *14*(8), 1-21. https://doi.org/10.3390/land14081520

Yang, H., Huang, W., Yang, D., & Jiang, Y. (2025). Innovation in comprehensive transportation network planning in the context of national spatial development: Institutional constraints and policy responses. *Land*, 14(5), 1-21. https://doi.org/10.3390/land14051046

Yaska, M., & Nuhu, B. M. (2024). Assessment of measures of central tendency and dispersion using likert-type scale. *African Journal of Advances in Science and Technology Research*, *16*(1), 33-45. https://doi.org/10.62154/ajastr.2024.016.010379

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