Quest Journals
Journal of Architecture and Civil Engineering
Volume 11 ~ Issue 1 (January 2026) pp: 55-63
ISSN(Online): 2321-8193
www.questjournals.org

Research Paper

Articulating Urban Transportation Route for Efficient Transport Network Services in Auchi and Its Environs

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Abstract
Urban transportation networks are critical to the socio-economic development of rapidly expanding cities, yet in many Nigerian urban centers such as Auchi, infrastructural inadequacies and policy implementation gaps have resulted in pervasive challenges. This study examines the efficiency of Auchi's urban transportation network and its impact on the socio-economic activities of residents, commuters, and business owners. A cross-sectional survey design was employed, with 150 structured questionnaires administered to a diverse sample representing key stakeholder groups. The questionnaire captured demographic profiles, perceptions of the current transport system, identification of critical infrastructural issues, and attitudes towards potential interventions such as multi-modal transport integration and advanced traffic management systems. Findings indicate that most respondents perceive the existing transport network as inefficient, with 70% reporting that the current road infrastructure is inadequate for the city's expanding population. Major challenges include severe traffic congestion, poor road conditions, and ineffective public transport options. Furthermore, the data reveal that transportation deficiencies significantly impede daily socio-economic activities, with over 60% of respondents indicating moderate to extreme adverse effects. Notably, there was overwhelming support—exceeding 80%—for integrating sustainable transport strategies and developing a comprehensive transportation network plan to alleviate these issues. The study concludes that addressing Auchi's transportation challenges requires urgent infrastructural upgrades, adopting multi-modal and sustainable transport solutions, and robust policy implementation. Such interventions are anticipated to improve urban mobility, reduce congestion, foster broader socio-economic development, and enhance Auchi's overall quality of urban life.

Keywords: *Auchi, Mobility, Traffic, Transportation, Urban*

R*eceived 12 Jan., 2026;* ***R****evised 23 Jan., 2026;* ***A****ccepted 25 Jan., 2026*
P*ublished with open access at* ***www.questjournas.org***

I. Introduction

Urban transportation networks serve as the lifeblood of rapidly expanding cities, ensuring the efficient movement of people and goods while bolstering socio-economic development (Makanadar & Shahane, 2024). The rapid urbanization in Nigerian cities has amplified the challenges associated with transportation infrastructure, with Auchi being a pertinent example of these complexities. The city's rapid population growth has starkly contrasted with the existing road network's limited capacity, resulting in congested routes and diminished urban mobility (Adeyemi & Akinyemi, 2022). Despite the existence of urban transport policies, the city's current road network remains inadequate, with critical gaps in connectivity that hinder effective traffic flow and compromise the overall efficiency of transport services (Adebola & Yusuf, 2021).

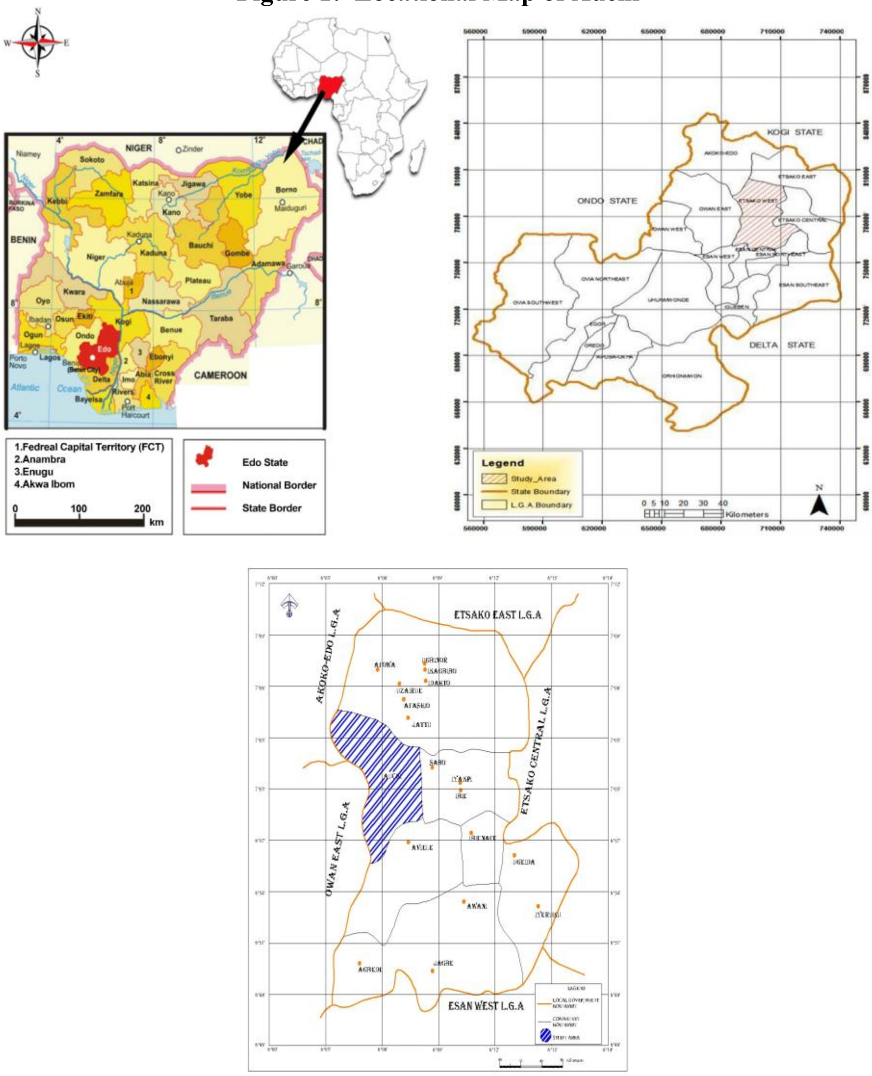
The challenges confronting Auchi's transportation landscape are multifaceted. First, the lack of a functional and comprehensive road network has rendered the city ill-equipped to cater to its expanding population (Ayo-Odifiri *et al*., 2021). Second, there is a pronounced deficiency in the systematic upgrading of existing road infrastructures—an omission that has exacerbated congestion, increased travel times, and fostered the emergence of informal transport solutions unable to meet the growing demand (African Development Bank, 2020). Third, while road development plans may exist in policy documents, their implementation is sporadic and insufficient to address the dynamic growth trends and traffic challenges within the city (UN-Habitat, 2020). Without sustainable strategies to manage traffic flow and a deliberate, detailed transportation network development plan, Auchi's prospects for achieving a resilient and efficient urban transport system remain uncertain (Akinbola & Omotayo, 2021).

Addressing these multifaceted issues necessitates an integrated approach that incorporates modern urban planning practices, robust policy implementation, and sustainable management strategies. Such a framework would not only facilitate more effective traffic management but also support the overall urban development agenda, ensuring that Auchi’s transport infrastructure evolves in tandem with its rapid urban expansion.

II. Study Area

Auchi is a prominent urban center located in Edo State, Nigeria. It is situated in Etsako West Local Government Area and serves as one of the most significant commercial and educational hubs in the state. Geographically, Auchi lies between latitude 7°04′N and 7°07′N and longitude 6°15′E and 6°20′E, placing it within Nigeria's rainforest-savanna transition zone (see Figure 1). (Onokerhoraye & Omuta, 2021).

Figure 1: Locational Map of Auchi



Source: Osayande, et al (2019)

Its strategic location along the Benin-Abuja expressway makes it an important transit point for commuters and goods between the southern and northern parts of Nigeria According to the National Population Commission's 1999 data, Auchi had an estimated population of 42,610 in 1991. Using a constant growth rate of 2.8% and the geometric projection method for 31 years, the projected population of Auchi in 2025 will be 109,234. The town is a melting pot of ethnic groups, predominantly the Afemai people, along with settlers from various parts of Nigeria. The population's growth rate has been spurred by its reputation as an educational centre, hosting the Federal Polytechnic Auchi, which attracts students and staff from across the country. This growth has also contributed to increasing urbanisation and expansion of the town’s boundaries.

Auchi experiences a tropical climate marked by two distinct seasons: the rainy season, which typically spans April to October, and the dry season, lasting from November to March. Average annual rainfall ranges between 1,500 mm and 2,000 mm, with peak rainfall occurring in July and September. The average temperature is relatively consistent throughout the year, ranging from 24°C to 31°C. Humidity levels are generally high, especially during the rainy season, while the Harmattan wind, a dry and dusty north-easterly trade wind, influences the climate during the dry season (Nigerian Meteorological Agency [NiMet], 2022).

The major linkages from other major settlements within Etsako and its environs that connect and benefit from the socio-economic, educational, and administrative infrastructures in Auchi, do so through five major link roads. These are the Warrake – Sbongida road linkage, the Ikpeshi – Igarra road linkage, the Elele – Okpella road linkage, Jattu – Agenebode road linkage, Iyakpi – Weppa road linkage and Aviele – Agbede road linkage. All of the above-listed linkages connect and terminate at the centre of the Central Business District of the study area

Auchi boasts a vibrant socio-economic landscape. The town is a significant commercial hub, with markets like the Auchi Main Market playing a pivotal role in trade and commerce. The economy is driven by small- and medium-scale enterprises, retail trading, and agricultural activities. The presence of the Federal Polytechnic Auchi also contributes to the local economy by generating employment and fostering entrepreneurial ventures. Key agricultural products include cassava, yams, maize, and oil palm. However, the town faces challenges related to urban planning, including inadequate infrastructure, traffic congestion, and environmental degradation, which have implications for its socio-economic development (Eke & Alufohai, 2023).

2.1 Conceptual Framework

2.1.1 Systems Thinking Approach

The systems thinking approach is a holistic method that examines urban transportation networks as dynamic, interrelated systems rather than as isolated components. This perspective is crucial for understanding the multiple feedback loops, interdependencies, and non-linear interactions that characterise modern urban environments. According to Meadows (2008), systems thinking encourages planners to identify leverage points within the transportation network where small interventions can yield disproportionately large improvements in system performance. For instance, by mapping out the interconnections between road infrastructure, public transit, and land use patterns, urban planners can pinpoint areas where enhancements will alleviate congestion and improve overall mobility.

Moreover, systems thinking facilitates the anticipation of unintended consequences by considering the ripple effects of any intervention. Sterman (2000) argues that modelling urban transport systems through system dynamics enables decision-makers to simulate various scenarios, thereby understanding long-term impacts before implementing policy changes. This approach not only enhances the robustness of planning decisions but also promotes stakeholder collaboration by making the complex web of urban interactions more transparent. Recent applications of systems thinking in urban transport planning have demonstrated its effectiveness in addressing issues such as traffic bottlenecks, multimodal integration, and environmental sustainability (Calleja, 2019). In summary, employing a systems thinking approach can help to ensure that the development of urban transportation networks is both resilient and adaptive to evolving urban challenges in Auchi.

2.1.2 Sustainable Urban Transport Planning (SUTP) Framework

The Sustainable Urban Transport Planning (SUTP) framework is designed to integrate economic, environmental, and social dimensions into the planning and development of urban transportation systems (Mavlutova, *et al,* 2023). This framework emphasises the need for transport solutions that not only address current mobility demands but also contribute to long-term urban sustainability. Banister (2008) introduces the sustainable mobility paradigm, which advocates for transport systems that minimise environmental impacts, reduce dependence on fossil fuels, and promote social equity. Central to the SUTP framework is the recognition that urban transport planning must balance efficiency with sustainability, ensuring that infrastructural developments do not compromise environmental quality or social inclusion.

Within the SUTP framework, multimodal integration is a key component. Pojani and Stead (2015) illustrate that successful urban transport systems require the seamless integration of various modes—such as buses, cycling, walking, and rail—to reduce traffic congestion and lower greenhouse gas emissions. Additionally, this framework calls for proactive demand management strategies that encourage public and non-motorised transport. Litman (2021) further underscores that effective sustainable transport planning involves rigorous cost-benefit analyses, stakeholder engagement, and the adoption of innovative technologies (e.g., real-time data analytics and GIS-based planning tools). By incorporating these elements, the SUTP framework provides a comprehensive guide for developing urban transportation networks that are resilient, efficient, and aligned with broader sustainability goals.

2.2 Literature Review

2.2.1 Transport Route Delineation in Urban Transportation

Transport route delineation is the process of systematically identifying and designing optimal pathways within an urban transport network to ensure efficient connectivity and accessibility. This process involves the utilisation of advanced spatial analysis techniques, particularly Geographic Information Systems (GIS) and multi-criteria decision-making (MCDM) tools, which allow urban planners to integrate diverse datasets such as land use, population density, and traffic patterns (Wang & Yin, 2020). By employing these methodologies, planners can generate detailed maps that highlight potential corridors for road development and improvement, thereby reducing travel time and enhancing overall network performance.

Moreover, modern delineation approaches increasingly incorporate real-time data and predictive modelling to respond to the dynamic nature of urban mobility. For instance, Lee and Park (2022) demonstrate how integrating live traffic data with route optimisation algorithms can enable dynamic adjustments to existing routes, thereby mitigating congestion during peak hours. Similarly, Chen (2022) emphasises that a GIS-based optimisation framework not only identifies the most efficient routes but also supports scenario planning by simulating the impacts of urban growth and infrastructural changes. Collectively, these advanced techniques form the backbone of contemporary urban transportation planning, ensuring that route delineation is both data-driven and adaptable to future developments.

2.2.2 Challenges of Transport Route Delineation

While the delineation of urban transport routes is critical for efficient network planning, several challenges can impede the process. One of the foremost issues is the quality and availability of data. Comprehensive route delineation relies on accurate spatial, traffic, and demographic data; however, discrepancies in data quality or limited access to updated datasets can severely constrain analytical outcomes (Santos & Martins, 2021). This challenge is further compounded by the inherent complexity of urban environments, where rapid and unplanned growth often results in fragmented and outdated infrastructural maps.

Another significant challenge is the integration of multi-modal transportation systems. Urban areas typically encompass various transport modes—such as private vehicles, buses, cycling lanes, and pedestrian pathways—which must be cohesively integrated into a single network. Gonzalez and Martinez (2021) note that legacy systems and piecemeal planning approaches often lead to disjointed networks, making it difficult to delineate routes that effectively serve all modes. Additionally, financial constraints and bureaucratic inefficiencies can hinder the adoption of advanced technologies and innovative planning practices. Davis and Smith (2020) highlight that funding limitations often delay the implementation of modern route delineation tools and impede the updating of critical infrastructure.

Furthermore, environmental and social considerations introduce another layer of complexity. Planners must balance the demand for efficiency with sustainability goals, ensuring that route improvements do not exacerbate environmental degradation or social inequities. Rashid and Thompson (2021) argue that sustainable urban transport planning requires a careful negotiation between economic benefits, environmental protection, and social inclusion. Collaborative approaches, involving a range of stakeholders from government, private sectors, and local communities, are thus essential to overcome these multifaceted challenges (Khan, Malik, & Raza, 2021).

2.2.3 Role of Urban Transportation Networks in Socio-Economic Development

Urban transportation networks are integral to the socio-economic development of cities. They facilitate the efficient movement of people and goods, thereby driving economic activities and enhancing access to essential services such as education, healthcare, and employment. Miller and Davis (2022) contend that robust transport infrastructures contribute directly to economic growth by reducing travel times, increasing productivity, and attracting investment. The ripple effects of improved urban mobility extend to various sectors, reinforcing the role of transportation as a catalyst for broader economic development.

In addition to economic benefits, well-designed transportation networks play a crucial role in promoting social equity. By connecting marginalised or underserved communities with central business districts and essential services, these networks help bridge spatial and socio-economic disparities. Singh and Patel (2022) have shown that equitable access to efficient transport can significantly reduce regional imbalances and foster social inclusion. Furthermore, urban transportation systems can enhance environmental sustainability by reducing the reliance on private vehicles, thereby mitigating traffic congestion and lowering greenhouse gas emissions (Olson & Zhang, 2021).

Urban transportation also underpins the functionality of other urban systems, contributing to urban resilience and quality of life. Roberts and Chen (2022) illustrate that cities with integrated and efficient transport networks are better positioned to respond to economic shocks and demographic shifts, as they offer the flexibility needed to accommodate changing urban dynamics. In summary, the strategic development of urban transportation networks not only boosts economic performance but also fosters social and environmental well-being, making it a cornerstone of sustainable urban development.

III. Methodology

This study employs a cross-sectional survey design to investigate the efficiency and challenges of urban transportation networks in Auchi, with a specific focus on the interplay between infrastructural deficits and socio-economic development. A total of 150 structured questionnaires will be administered to a randomly selected sample of Auchi residents, daily commuters, and local business owners, ensuring that the sample is representative of the diverse stakeholder groups affected by urban transport issues. The questionnaire is designed to capture detailed information on respondents' perceptions regarding the adequacy of the current road network, the impact of rapid urbanisation on traffic congestion, and the effectiveness of existing transport policies. Data collected will be analysed using both descriptive and inferential statistical techniques via software such as SPSS, thereby enabling the identification of significant trends and correlations between transport inefficiencies and socio-economic indicators. This methodological approach is guided by established survey research practices, ensuring rigour and reliability in the data collection process (Creswell, 2018; Saunders, Lewis, & Thornhill, 2019).

IV. Findings

Table 1: Demographic Information

Variable	Category	Frequency (N)	Percentage (%)
Age	Under 18	8	5.3
	18–24	36	24.0
	25–34	54	36.0
	35–44	30	20.0
	45–54	15	10.0
	55 and above	7	4.7
Gender	Male	90	60.0
	Female	57	38.0
	Other	3	2.0
Occupation	Student	68	45.3
	Employed (Public Sector)	23	15.3
	Employed (Private Sector)	30	20.0
	Self-employed	15	10.0
	Unemployed	10	6.7
	Other	4	2.7
Length of Residence in Auchi	Less than 1 year	15	10.0
	1–3 years	38	25.3
	4–6 years	45	30.0
	7–10 years	30	20.0
	More than 10 years	22	14.7
Frequency of Using Urban Transportation Services	Daily	60	40.0
	Several times a week	45	30.0
	Weekly	23	15.3
	Occasionally	15	10.0
	Rarely/Never	7	4.7

Source: Field survey, 2025

The demographic profile indicates that the largest age group is 25–34 years (36%), with a majority of respondents being male (60%). Nearly half of the respondents are students (45.3%), suggesting a youthful and possibly transient population. Most respondents have resided in Auchi for 4–6 years (30%), and a substantial number use urban transportation services daily (40%). These findings suggest that the study captures perspectives from a predominantly young, student-based population who are regular users of the urban transport network.

Table 2: Perceptions of Urban Transportation Networks (Merged SPSS Table)

Variable	Category	Frequency (N)	Percentage (%)
Overall Efficiency of Auchi's Urban Transportation Network	Very inefficient	15	10.0
	Inefficient	53	35.3
	Neutral	45	30.0
	Efficient	30	20.0
	Very efficient	7	4.7
Adequacy of Current Road Network (Meets Needs of Expanding Population)	Yes	45	30.0
	No	105	70.0
Critical Issues (Multiple Responses) – Urban Transportation System	Traffic congestion	120	80.0
	Poor road conditions	98	65.3
	Inadequate public transport options	113	75.3

	Lack of proper road maintenance	83	55.3
	Inefficient traffic management	105	70.0
	Other	8	5.3
Agreement on Integrating Multi-modal Transport Options	Strongly disagree	8	5.3
	Disagree	15	10.0
	Neutral	30	20.0
	Agree	67	44.7
	Strongly agree	30	20.0
Effectiveness of Current Urban Transport Policies in Managing Traffic Flow	Very ineffective	60	40.0
	Ineffective	45	30.0
	Neutral	22	14.7
	Effective	15	10.0
	Very effective	8	5.3

Source: Field survey, 2025

The majority of respondents rate the overall efficiency of Auchi's urban transportation network as "Inefficient" (35.3%) or "Neutral" (30%), with only a small percentage finding it "Efficient" or "Very efficient" (24.7% combined). Seventy percent of respondents believe that the current road network does not adequately meet the needs of the expanding population. Critical issues such as traffic congestion (80%), inadequate public transport options (75.3%), and inefficient traffic management (70%) are prominently identified. Additionally, over 64% (combining "Agree" and "Strongly agree") support the integration of multi-modal transport options, yet a significant proportion (70%) view current transport policies as ineffective in managing traffic flow.

Table 3: Challenges in Road Infrastructure

Variable	Category	Frequency (N)	Percentage (%)
Impact of Non-functional Road Network on Traffic Congestion	Strongly disagree	3	2.0
	Disagree	12	8.0
	Neutral	30	20.0
	Agree	60	40.0
	Strongly agree	45	30.0
Frequency of Delays/Inconveniences Due to Inadequate Road Infrastructure	Very rarely	8	5.3
	Rarely	23	15.3
	Sometimes	51	34.0
	Often	45	30.0
	Very often	23	15.3
Observation of Increased Use of Informal Transport Solutions	Yes	128	85.3
	No	22	14.7
Importance of Upgrading Existing Road Networks	Not important	3	2.0
	Slightly important	12	8.0
	Moderately important	30	20.0
	Very important	60	40.0
	Extremely important	45	30.0
Perception of Policy Implementation Gap in Urban Transport	Yes	120	80.0
	No	30	20.0

Source: Field survey, 2025

A combined 70% of respondents (40% "Agree" and 30% "Strongly agree") indicate that a non-functional road network significantly contributes to traffic congestion. A majority (64%) report experiencing delays "Sometimes" or "Often" due to inadequate road infrastructure. A substantial 85.3% have noticed an increase in the use of informal transport solutions (e.g., motorcycle taxis) as a coping mechanism. Furthermore, 70% (combining "Very important" and "Extremely important") rate the upgrading of existing road networks as crucial for improving urban mobility, and 80% perceive a significant gap between the formulation and implementation of urban transport policies.

Table 4: Socio-Economic Implications and Suggestions for Improvement

Variable	Category	Frequency (N)	Percentage (%)
Impact of Transportation Challenges on Daily Socio-Economic Activities	Not at all	8	5.3
	Slightly	24	16.0
	Moderately	50	33.3
	Significantly	45	30.0
	Extremely	23	15.3
Impact of Advanced Traffic Management Systems on Daily Commutes	Very negatively	8	5.3
	Negatively	15	10.0
	No impact	22	14.7
	Positively	60	40.0
	Very positively	45	30.0
Support for Developing a Detailed, Sustainable Transportation Network Plan	Yes	135	90.0
	No	15	10.0

Favourability Towards Integrating Sustainable Transport Strategies	Strongly oppose	3	2.0
	Oppose	8	5.3
	Neutral	15	10.0
	Support	75	50.0
	Strongly support	49	32.7

Source: Field survey, 2025

The data indicate that transportation challenges have a noticeable impact on daily socio-economic activities, with 63.3% (combining "Significantly" and "Extremely") reporting a moderate to extreme negative effect. The introduction of advanced traffic management systems is perceived positively by 70% of respondents, suggesting that such interventions could improve daily commuting conditions. There is overwhelming support for the development of a sustainable transportation network plan (90% in favour), and 82.7% express a positive stance (either "Support" or "Strongly support") towards integrating sustainable transport strategies. Qualitative comments consistently call for immediate infrastructure improvements, multi-modal integration, and bridging the gap between policy formulation and implementation.

V. Summary of Findings

The merged SPSS outputs provide a comprehensive snapshot of the demographic profile, perceptions, challenges, and socio-economic impacts of Auchi's urban transportation network. The majority of respondents are young, predominantly students, and regular users of urban transport services, reflecting a dynamic urban population. Perceptions of the transportation network are largely negative, with significant concerns regarding inefficiency, inadequate infrastructure, and ineffective policies. Respondents overwhelmingly identify traffic congestion, poor road conditions, and a lack of adequate public transport options as critical issues.

The challenges in road infrastructure are evident through the high frequency of delays and the increased reliance on informal transport solutions, underscoring the urgent need for systematic upgrades and improved policy implementation. Socio-economic implications are substantial, with most respondents reporting that transportation challenges negatively affect their daily activities, yet there is strong support for modern, sustainable interventions such as advanced traffic management systems and a comprehensive transportation network plan.

5.1 Recommendations

Based on the data, several key recommendations emerge to address the challenges and enhance urban mobility in Auchi:

i. **Infrastructure Upgrades:**
   Road Network Improvements: Given that 70% of respondents believe the current network is inadequate, immediate upgrades and expansion of the existing road infrastructure are imperative. This could involve not only road widening and maintenance but also the construction of new roads to cater to the growing population (Adeyemi & Akinyemi, 2022).
   Multi-Modal Integration: The strong support for multi-modal transport options (64% in agreement) suggests that Auchi should invest in integrating buses, cycling lanes, and pedestrian pathways to offer alternatives that reduce reliance on congested roads (Pojani & Stead, 2015).

ii. **Advanced Traffic Management Systems:**
   GIS-Based Monitoring: With 70% of respondents perceiving a positive impact from advanced traffic management, deploying GIS and real-time traffic monitoring systems can help manage congestion and dynamically optimise traffic flow (Lee & Park, 2022).
   Data-Driven Decision-Making: Utilising data analytics to forecast traffic patterns and manage peak-hour congestion can further refine urban transport planning.

iii. **Policy Implementation and Stakeholder Engagement:**
   Bridging the Policy Gap: With 80% of respondents noting a significant gap between policy formulation and implementation, it is essential for local government authorities to ensure that existing urban transport policies are executed effectively. This could be achieved through stronger inter-agency coordination and enhanced accountability measures (UN-Habitat, 2020).
   Stakeholder Involvement: Engaging local communities, businesses, and other stakeholders in the planning process can help tailor solutions to real needs and ensure broader support for initiatives.

iv. **Sustainable Transport Strategies:**
   Promotion of Eco-friendly Options: Encouraging the adoption of sustainable transport methods, such as electric public transport and non-motorised travel can help to reduce environmental impacts and improve overall urban liveability (Banister, 2008).
   Public Awareness Campaigns: Constant campaigns should inform the public about the benefits of sustainable transportation and the long-term benefits of infrastructure improvements.

5.2 Conclusion

The findings of this study show the critical state of Auchi's urban transportation network amid rapid urbanisation. The data highlight significant infrastructural deficiencies, policy implementation gaps, and a heavy reliance on informal transport solutions—all of which contribute to pervasive traffic congestion and negatively impact socio-economic activities. However, the strong public support for advanced traffic management systems and sustainable transport strategies presents a viable pathway for improvement. By investing in comprehensive infrastructure upgrades, integrating multi-modal transport options, and ensuring robust policy implementation through stakeholder collaboration, Auchi can transform its urban transportation network into a catalyst for socio-economic development and enhanced quality of life. The study ultimately calls for urgent and coordinated action to align Auchi's transport infrastructure with the demands of its growing population, thereby paving the way for a more efficient, sustainable, and inclusive urban future.

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