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Impact of Road Transport Infrastructure on Commercial Transportation in Kano Municipality

Abubakar Abdullahi[1*], Zubairu Abubakar Ghani[1], Sani Jibir Dukku[1], Lumi Zamani Haruna[1], Omeiza David Idris[1], Yusuf Yakubu Yusuf[1]

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ABSTRACT

Road transport carries virtually all passenger and freight movement in Kano, yet the physical network that supports it remains under-provisioned. Almost all passenger and freight movement in Kano is carried by road transport, but the physical infrastructure supporting it is still underdeveloped. This study used a mixed-method survey design to examine how the state and distribution of road transport infrastructure shape commercial transportation in Kano Municipality, with the goal of recommending measures for improving service delivery. Cochran's formula produced a sample of 384 respondents drawn through multistage sampling across wards in Fagge and Tarauni, complemented by nine key informant interviews, a route-by-route infrastructure checklist covering 26 corridors, and direct field observation. The quantitative data were analyzed using descriptive statistics and linear regression in SPSS. With 68.8% of respondents using tricycles as their primary mode of transportation and 75.3% of respondents using commercial modes on a daily basis, reliance on commercial transportation was found to be high. Overall, infrastructure received a reasonable rating; bus stations and terminals received the lowest score of 2.57, while road signs received the highest mean score of 3.39. This pattern was reflected in service efficiency: modal integration (2.64) and trip time (2.86) were weak, whereas affordability (3.81) and accessibility (3.59) were quite strong. Regression confirmed a statistically significant but weak relationship between infrastructure and commercial transport use ($R^2 = 0.061$; $F = 5.377$, $p < 0.001$), streetlights ($\beta = 0.154$), overpasses ($\beta = 0.126$) and lane markings ($\beta = 0.117$) emerging as significant positive predictors. Existing infrastructure is therefore insufficient for prevailing demand, producing a system that is affordable and widely available yet inefficient, mono-modal and spatially unequal. Increased investment, terminal provision, regulation of informal operators and Transit-Oriented Development principles are recommended.

INTRODUCTION

According to Adeniran (2016), a road is a planned path that connects two points in space, and road transport refers to the movement of people, products, and services along that network by vehicles such as taxis, buses, tricycles, motorbikes, and haulage trucks. Pre-colonial footpaths and porterage gave rise to Nigeria's system, which was reorganized under colonial administration to support cash-crop exports. Today, the road mode accounts for more than 85% of the country's passenger and goods movement (Farouq *et al.*, 2017; Olorunfemi, 2021). The majority of Nigerian metropolitan centers lack the mass transportation systems that handle a large portion of the traffic in similar cities elsewhere, and rail and inland waterways only make a minor contribution. According to Adeniran (2016), a road is a planned path that connects two points in space, and road transport refers to the movement of people, products, and services along that network by vehicles such as taxis, buses, tricycles, motorbikes, and haulage trucks. Pre-colonial footpaths and porterage gave rise to Nigeria's system, which was reorganized under colonial administration to support cash-crop exports. Today, the road mode accounts for more than 85% of the country's passenger and goods movement (Farouq *et al.*, 2017; Olorunfemi, 2021). The majority of Nigerian metropolitan centers lack the mass transportation systems that handle a large portion of the traffic in similar cities elsewhere, and rail and inland waterways only make a minor contribution. There is ample documentation of the developmental stakes. Transportation investment improves urban liveability, lowers poverty, and boosts competitiveness, according to data from the US, Brazil, China, and Poland (Rokicki *et al.*, 2021; Zhou *et al.*, 2022). The opposite situation is Nigeria. Only 1–5% of GDP is contributed by transportation, compared to 11–16% in developed nations (Oni & Okanlawon, 2004). Inadequate provision raises company expenses by an estimated 7–8% and discourages foreign investment (Hamza, 2019). Inadequate roads result in longer commutes, less access to opportunities, and increased travel stress at the family level (Suleiman *et al.*, 2024). Kano refines these broad insights. Since all commercial transportation in the city is road-based and relies on buses, taxis, tricycles, and motorbikes (Abdullahi *et al.*, 2024; Chi & Udo, 2020), the quality of the road network is essentially the single factor that determines mobility rather than one of several. Driven by insecurity and the need for employment, migration from nearby towns and neighboring states has increased the population and accelerated construction, creating movement demand that has outpaced the

[1] Department of Urban and Regional Planning at Abubakar Tafawa Balewa University (ATBU), Bauchi - Nigeria
[*] Corresponding author's e-mail: abakarabdullahi08054321@gmail.com

expansion of road capacity, supplementary facilities, and traffic management techniques (Aliyu, 2021; Ogunbodede, 2008). The network's badly maintained pavements, lack of drainage, inadequate parking, and almost complete absence of designated bus lanes and terminals persist despite ongoing maintenance expenditures. These deficiencies worsen traffic and deter the use of larger buses. Road transport received ₦ 12.2 billion, or 17.26% of the infrastructure envelope and 2.22% of overall yearly spending, of the ₦ 70.68 billion the Kano State Government pledged to infrastructure in its 2025 budget (Kano State Government, 2024). Visible capital projects have been the focus of interventions thus far. Although the Federal Road Safety Corps, the Kano Road Traffic Agency, and the police have been deployed along with the dualization of major corridors and the construction of flyovers, mobility issues still exist. The concept of maintenance itself has been limited, focusing on pavement while ignoring drainage, culverts, street lights, bus stops, and median dividers (Ahmad *et al.*, 2018; Farouq *et al.*, 2017; Yusuf *et al.*, 2021). The overall impact limits the sustainability, affordability, dependability, and efficiency of commercial transportation throughout the city. While previous research has documented the overall economic benefits of transportation infrastructure, it has focused very little on the precise mechanism via which inadequate infrastructure impairs the operation of commercial transport services in a quickly expanding African metropolis. That gap is filled by this study. Through four objectives, it investigates how road transport infrastructure affects commercial transportation in Kano Municipality: evaluating the current condition of road transport infrastructure; evaluating its impact on commercial transport operations; evaluating how the spatial distribution of infrastructure affects commercial transport efficiency across zones; and identifying the infrastructure-related challenges facing users and operators. According to the related hypothesis, there is no connection between the research area's road infrastructure and business transportation.

LITERATURE REVIEW

According to Isaac *et al.* (2020), transportation is typically defined as the movement of people and products from one place to another. The need for transportation is derived rather than intrinsic, as individuals travel for social obligations, employment, education, and markets rather than for their own purpose. According to Iles (2005), transportation is essential to civilized life because it transports people from their homes to places of daily activity and goods from production to consumption. Roads, railroads, rivers, pipelines, and terminals like bus stops, warehouses, and refueling depots make up the fixed framework that permits this circulation (Onyeocha *et al.*, 2015). It is one of the hard infrastructures that an economy cannot operate without, according to Olanrewaju (2011). According to the literature, transportation infrastructure is essential for development at all socioeconomic levels (Ebelechukwu *et al.*, 2024; Heintz *et al.*, 2009). The transportation system functions as a tool of social, political, and economic integration that fortifies markets and promotes resource development (Aigbedion *et al.*, 2015). For developing economies in particular, sufficient provision keeps transportation costs low and enhances competitive standing (Flyvbjerg *et al.*, 2004). However, budgetary constraints have reduced investment in many nations, reducing development potential and increasing unmet demand, which has an impact on income distribution and poverty (Calderón & Servén, 2003; Percoco, 2014). An estimated $15 billion is needed per year to close Nigeria's infrastructure deficit (Igwe *et al.*, 2013).

Commercial and public transport in Nigerian cities

Fee-paying passenger cars that operate unofficially make up commercial transport, which is referred to as paratransit in international literature. It takes many different forms, including minibuses like the Lagos danfo, shared taxis, motorcycle taxis known locally as okada, and converted vans and pick-ups (Armstrong-Wright, 1993). Although these services are highly valued for their ability to reach low-density corridors and tiny streets that large buses cannot economically operate, they have a reputation for being dangerous due to bad driving habits, poor maintenance, and chronic overcrowding. In contrast, high-capacity trucks are used on predetermined routes according to published schedules in formal public transportation. According to Kassa (2014), the lack of high-capacity alternatives is the reason why informal modes are more common in a large portion of the developing globe. Kano's intra-urban service developed as a complement to the railway and the airport, with buses appearing in the 1950s (Liman, 2008). The railway station became unusable as a transfer point due to the suspension of rail services, and bus service only gradually increased in tandem with the built-up area's explosive growth. The city is currently served by four bus transfer terminals, although there is still insufficient communication between them. For example, Bata and Yan Kura are less than two kilometers apart, but there is no bus service connecting them. Taxis operate without fixed routes from motor parks and favoured pick-up points. Motorcycles and later tricycles filled the void left by the delayed development of bus services, inadequate planning and enforcement, and deteriorating township roads. Tricycles took over after motorcycle taxis were outlawed in 2013 due to security concerns. Motorcycle taxis had been in operation since 1983. It is usual for buses, taxis, and tricycles that are supposed to hold 10, four, and three passengers to actually carry twelve, six, or five.

Effects of road infrastructure on commercial operations

Operating costs, service dependability, and ultimately economic output are all influenced by the quality of the infrastructure. According to Djajasinga (2021), a

well-developed transportation system supports regional prosperity by ensuring a steady supply of goods, ease of distribution, and price stability. Through operational efficiency, transport networks that connect markets to supply sources provide scale effects and increase productive capacity (Baldwin & Okubo, 2006; Nocke, 2006). With multiplier effects for the overall economy, employment implications go far beyond drivers to include mechanics, dealers of spare parts, fuel stores, and car washes (Onokala & Olajide, 2020). Good road infrastructure increases productivity and reduces production costs, especially in agriculture, according to Aigbedion *et al.* (2015). Increasing labor and capital productivity as direct inputs, creating cost savings through efficiency, promoting industrial agglomeration, and changing aggregate demand are the four ways that transport investment affects growth (Baldwin & Forslid, 2000; Gunasekera *et al.*, 2008; Pradhan & Bagchi, 2013).

Spatial distribution and equity

Development is uneven when transportation facilities are distributed unevenly. Communities with limited mobility have poorer living conditions and economic performance (Usman, 2014), ineffective industrial and population distribution, poor agricultural marketing, and limited access to banking, healthcare, security, and education (Anjorin, 2024). While Olomola (2003) relates patterns of poverty across Nigerian communities in part to inadequate transportation provision, Berg and Ihlström (2019) approach limited transit choice as a barrier to social participation. Environmental factors exacerbate spatial disadvantage: extreme weather disrupts services and damages roads, bridges, and tunnels (Chen & Chen, 2020; Zhang & Zhu, 2021); flooding in Lagos closes roads, damages pavements, and creates potholes that result in accidents and vehicle damage (Olorunfemi *et al.*, 2022).

Infrastructure-related challenges

Urban transport services in Nigeria are inadequate in both quality and quantity relative to population growth and household purchasing power (Adeyinka, 2013). According to Dike (2012), the expansion of the social and economic sectors has outpaced the availability of transportation, making it impossible to meet the demands of mobility. According to Olomola (2003), the ensuing issues include poor roads, fuel supply issues and expensive tolls, traffic jams and lengthy wait times, a lack of high-capacity vehicles and the ensuing overloading, expensive and hard-to-find spare parts, inadequate maintenance, and aging fleets. According to Onokala and Olajide (2020), Nigeria's urban transportation issue is characterized by inadequate supplementary amenities, inefficient administration, and poorly built and maintained networks. A portion of this, according to Aworemi and Ajayi (2013), might be attributed to the lack of a unified legally recognized transport policy, which leaves development dispersed and haphazard. According to Adepoju (2021), axle loads that frequently above the authorized nine tons reduce pavement life, particularly during rainy seasons, and subpar design specifications and outdated norms are also noted. According to Okunlola (2018), the Federal Road Maintenance Agency lacks the resources, tools, and technical know-how necessary to carry out its task, and Olaogun (2012) notes a political inclination toward building new infrastructure rather than maintaining current assets. Transit-Oriented Development, introduced by Calthorpe (1993), offers an integrated approach to transport and land-use planning that makes walking, cycling and transit use convenient while maximising the efficiency of existing services by concentrating development around transit nodes (Thomas & Bertolini, 2015). Its logic is to reduce dependence on private vehicles by reshaping urban form (Tamakloe *et al.*, 2021). Cervero and Kockelman (1997) articulate three pillars, commonly termed the 3Ds: density sufficient to support transit, diversity of land use to generate two-way demand, and design that produces pedestrian-friendly walkways and seamless transfer. The framework has been applied at city scale in Stockholm, Copenhagen, Hong Kong, Tokyo and Singapore (World Bank, 2024), and is associated with improved service efficiency, more active travel environments, shorter average trip distances and gains in health, safety, equity and urban identity (Padeiro *et al.*, 2019; Yen *et al.*, 2024). Applied to Kano, Transit-Oriented Development supplies a framework for optimising the use of existing road capacity rather than relying on continuous expansion. Its emphasis on dedicated pedestrian walkways, cycling lanes, bus lanes and well-designed stops speaks directly to the deficits documented in the metropolis, and its concern with seamless transfer addresses the mono-modal dependence on tricycles. The literature reviewed establishes the general returns to transport infrastructure but leaves largely unexamined the specific pathway by which infrastructural inadequacy translates into commercial transport inefficiency in a rapidly urbanising Nigerian city. This study addresses that gap for Kano Municipality.

MATERIALS AND METHODS

Study area

Kano metropolis lies between latitudes 11°52'22"N and 12°07'19"N and longitudes 8°34'56"E and 8°47'11"E at an elevation of approximately 472 metres, bounded by Minjibir to the north-east, Gezawa to the east, Dawakin Kudu to the south-east, Madobi and Tofa to the south-west, and Dawakin Tofa to the north-west (Figure 1). The settlement originated between the sixth and seventh centuries when iron-smelters migrating from Gaya were drawn by ore deposits and the defensive advantage of Dala hill. Weaving, dyeing and tanning followed, and the establishment of the Kurmi market consolidated Kano's position as a trading centre whose caravan routes evolved into the federal highways serving the metropolis today.

Kano State was created on 27 May 1967, after which migration and commercial activity intensified. The walled

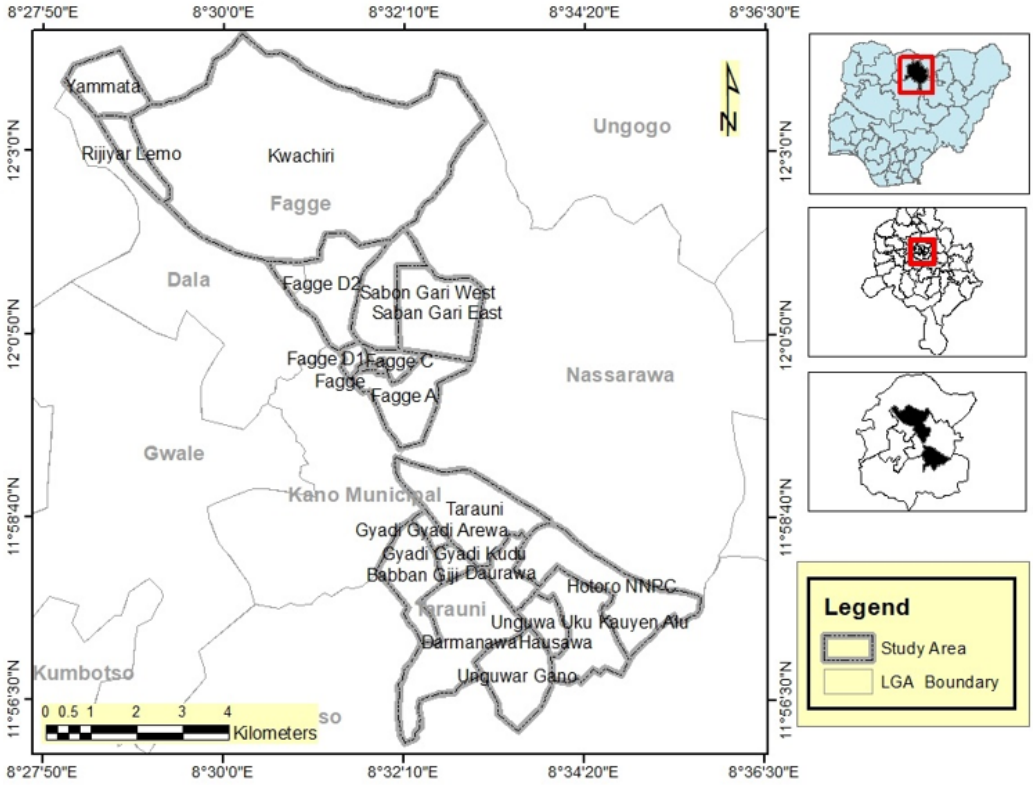

Figure 1: Locational map of the study area. Source: Cartography Laboratory, Department of Geography, Bayero University Kano (2025).

city retains a nucleated settlement pattern of irregular plot shapes and narrow streets that constrains vehicle circulation and parking. By 1980 the built-up area had spread beyond its colonial limits, absorbing surrounding villages and accommodating new housing estates. Kano holds Nigeria's second-largest metropolitan population after Lagos, distributed across eight Local Government Areas following the 1996 boundary adjustments: Kano Municipal, Fagge, Dala, Gwale, Tarauni, Nassarawa, Ungogo and Kumbotso. The climate is tropical wet and dry under the Köppen classification, with temperatures ranging from about 21°C in December and January to 31°C in March and April. More than 90% of annual rainfall falls in a short humid season, typically in evening storms of one to three hours' duration and high intensity, producing a high runoff coefficient. This concentration of rainfall places severe demands on road drainage, and drainage adequacy consequently bears directly on pavement durability, traffic efficiency and operating costs. Commercial activity in the municipality has expanded through new specialised agricultural markets, industrial estates, large departmental stores and service complexes, all of which depend on road access; efficient roads lower transport costs and speed deliveries, while poor roads generate congestion, vehicle damage, delays and higher fares (Mustapha & Yakudima, 2008).

Data sources and sampling

The study adopted a survey design with a mixed-method approach, chosen because combining numerical measurement with participant perspective yields a fuller account of the research problem than either alone, and because quantitative patterns can be explained by qualitative material gathered from the same setting (Creswell, 2014). The study population comprised three groups: residents, commercial transport operators and their unions, and institutional actors responsible for road transport policy and maintenance. Resident figures for Fagge and Tarauni were derived from the 2006 National Population Census projected to 2025, giving a combined sampling frame of 614,075 persons across twenty wards. Institutional populations were obtained from staff lists of the Kano Road Traffic Agency (KAROTA, 500), the Kano Road Maintenance Agency (KARMA, 312) and the Kano State Ministry of Transport (150). Operator populations were drawn from union registers: 254 bus drivers, 218 taxi drivers and approximately 5,000 tricycle operators (Table 1).

Given the size of the frame, Cochran's formula for finite populations was applied at a 95% confidence level ($Z = 1.96$), assumed proportion $p = 0.5$ and margin of error $e = 0.05$:

$$n = Z^2 p (1 - p) / e^2 = (1.96)^2 \times 0.5 \times 0.5 / (0.05)^2 = 384$$

Table 1: Stakeholder groups involved in transportation in Kano metropolis

Stakeholder category	Actor	Population
Institutional actors	Kano Road Traffic Agency (KAROTA)	500
	Kano Road Maintenance Agency (KARMA)	312
	Kano State Ministry of Transport	150
Operators	Bus drivers	254
	Taxi drivers	218
	Tricycle operators	5,000
Residents	Fagge	55,197
	Tarauni	558,878

Source: Fieldwork (2025).

A minimum of 384 respondents was therefore taken as adequate, distributed across users, residents, operators, unions and institutional stakeholders to secure representativeness. Multistage sampling was employed. Stratification first delineated the study area by ward, ensuring that no ward was omitted and improving both representativeness and precision. Simple random sampling then selected household heads, operators, commuters and stakeholders within strata, giving each member an equal probability of selection and minimising selection bias across user groups and geographical zones. Respondents were required to be aged eighteen or above. For the qualitative component, purposive sampling identified nine key informants with specific knowledge of commercial transportation, drawn from commuters, operators, the Ministry of Transport, KARMA, KAROTA, the Kano State Urban Planning and Development Authority, and transport unions. All 384 administered questionnaires were retrieved and processed.

Variables and measurement

Three primary instruments were deployed. A structured infrastructure assessment checklist evaluated road surface condition, carriageway width measured by tape, drainage, signage, traffic control devices, street lighting, pedestrian crossings, bus lanes, bus stop facilities and pavement across 26 selected routes, each element rated on a four-point scale from very good to poor. A structured questionnaire captured travel patterns, fares, distance, waiting and travel time, comfort, accessibility, service frequency, safety and user satisfaction. A structured interview guide elicited stakeholder perspectives on infrastructure condition, service efficiency, affordability, safety, challenges and improvement strategies. Field observation supplemented these with direct inspection of physical conditions, including potholes, cracks, corrugation, encroachment and traffic density expressed as vehicles per unit length of road. Secondary material was drawn from academic journals, government policy documents and published studies on transport in Kano. Perceptual variables were measured on five-point Likert scales. Infrastructure condition and service efficiency items ran from very good (5) to very poor (1); impact and challenge items ran from strongly agree (5) to strongly disagree (1). Mean scores were computed for each item, with 3.00 as the neutral midpoint. The dependent variable in the inferential model was the commercial transport mode principally used, and the twelve independent variables were the rated infrastructure components listed in Table 3. Reliability was established through a pilot test administered to 30 respondents outside the main sample, with Cronbach's alpha computed for internal consistency and a threshold of 0.70 adopted as acceptable (Orodho, 2009). Content validity was secured by review of the questionnaire and checklist by three experts in transportation studies and educational measurement, whose comments prompted minor adjustments for clarity and alignment with the research objectives before final administration (Mugenda & Mugenda, 2003). Informed consent was obtained from all participants, anonymity and confidentiality were preserved, and the study observed standard ethical requirements for social science research.

Data analysis methods

Quantitative data were analysed in the Statistical Package for the Social Sciences and Microsoft Excel. Descriptive statistics comprising frequencies, percentages and means summarised responses and ranked variables. The hypothesis was tested by linear regression, with the mode of commercial transport principally used regressed on the twelve rated infrastructure components. Model adequacy was assessed through the coefficient of determination and the analysis of variance F-statistic, and the contribution of individual components was read from standardised beta coefficients at a 0.05 significance threshold. Qualitative interview material was analysed thematically and integrated with the quantitative results to supply explanatory depth. The general form of the estimated model was:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_{12} X_{12} + \varepsilon \quad (1)$$

where Y denotes the commercial transport mode principally used, X_1 to X_{12} the rated road infrastructure components, α the intercept, β the coefficients and ε the error term.

RESULTS AND DISCUSSION

Descriptive results

Respondents were predominantly male (80.2%) and married (55.2%), with 49.2% aged between 37 and 54 years and a further 37.3% between 19 and 36. Educational attainment clustered at secondary level (30.2%), with 25.3% holding tertiary qualifications, 19.8% primary schooling only and 23.2% no formal education. Personal business and trading accounted for the largest occupational share (47.9%), followed by students (25.0%), civil servants (22.4%) and farmers (4.7%). Income was concentrated at the lower end: 39.1% earned below ₦70,000 monthly and a further 35.6% between ₦71,000 and ₦ 140,000. Hausa respondents formed 57.3% of the sample and Fulani 27.6%. Households of seven to nine persons were most common (37.2%). Residential tenure was substantial, 71.3% having lived in the area more than eleven years. By category, 71.3% were road users, 24.0% transport operators and 4.7% officials of government transport agencies. The sample therefore reflects a male-dominated, middle-aged, economically active and largely low-income population whose views rest on sustained practical experience of the system, and the preponderance of road users strengthens the representation of everyday transport experience.

Dependence on commercial transport is high. As Table 2 shows, 75.3% of respondents travel by commercial modes daily, with weekly (12.2%), occasional (7.3%) and rare (5.2%) use forming the remainder. Tricycles dominate the modal split at 68.8%, ahead of shared taxis (11.2%), minibuses (9.4%), e-hailing services (4.4%) and motorcycles (4.2%). No respondent reported using large buses, a finding that registers the practical absence of high-capacity services from the municipality (Figure 2). The pattern indicates a mobility system driven by informal provision, with tricycles preferred for their accessibility and affordability. Figure 3 illustrates this dominance along Ibrahim Taiwo Road in Fagge Local Government Area, where tricycles occupy the greater part of the traffic stream. The finding aligns with evidence from Kano and elsewhere in Nigeria that tricycles have become the dominant urban public transport mode (Abdullahi *et al.*,

Table 2: Use of commercial transport by respondents (n = 384)

Usage variable	Category	Frequency	Percentage (%)
Frequency of use	Daily	289	75.3
	Weekly	47	12.2
	Occasionally	28	7.3
	Rarely	20	5.2
Mode principally used	Tricycles	264	68.8
	Shared taxis	43	11.2
	Minibuses	36	9.4
	E-hailing taxis	17	4.4
	Motorcycles	19	4.2
	Others	5	1.3
	Big buses	–	–

Source: Fieldwork (2025).

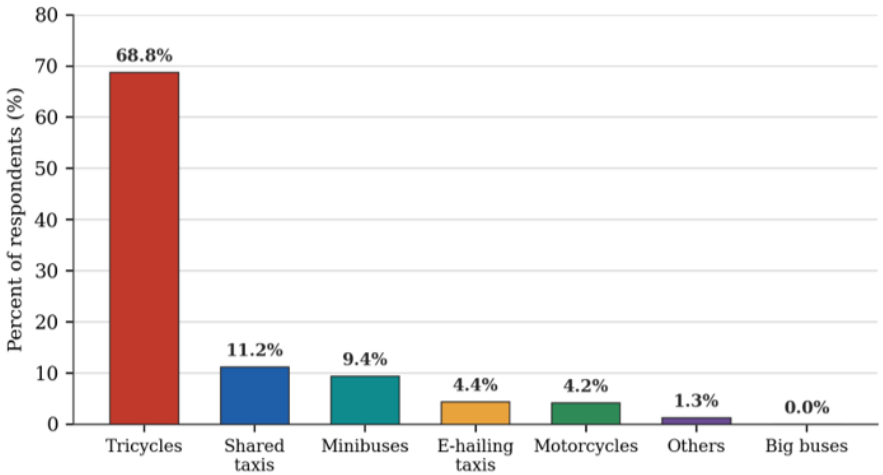

Figure 2: Distribution of commercial transport modes principally used by respondents.
Source: Fieldwork (2025).

2024; Ipingbemi & Adebayo, 2016; Isaac *et al.*, 2020), and reflects Kassa's (2014) observation that informal modes predominate where high-capacity services are unavailable.

Figure 3: Tricycles as the dominant form of commercial transport along Ibrahim Taiwo Road, Fagge Local Government Area, Kano.
Source: Fieldwork (2025).

Table 3 reports respondent assessments of the twelve infrastructure components. Road surfaces were rated fair by 62.0%, good by 18.0% and very good by 9.4%, with 10.6% recording poor. Lane markings, medians and shoulders returned an almost identical distribution. Traffic management systems including signals and wardens were rated fair by 56.8% and good by 22.4%. Road safety features such as guardrails and crash barriers drew a fair rating from 69.5% but poor from 17.7%, with only 3.1% judging them very good. Signage performed comparatively well, rated good or very good by 37.0% in combination. Bus stops and terminals stand apart as the only component rated poor by a majority (54.9%), with just 9.6% rating them good or very good.

Table 3: Existing condition of road transport infrastructure in Kano Municipality (n = 384)

Infrastructure component	Very good F (%)	Good F (%)	Fair F (%)	Poor F (%)	Mean
Road signage	49 (12.8)	93 (24.2)	203 (52.9)	39 (10.1)	3.39
Traffic management systems	42 (10.9)	86 (22.4)	218 (56.8)	38 (9.9)	3.34
Drainage systems	47 (12.2)	60 (15.6)	254 (66.2)	23 (6.0)	3.34
Pedestrian crossings and sidewalks	49 (12.8)	68 (17.7)	228 (59.4)	39 (10.2)	3.33
Streetlights	44 (11.5)	58 (15.1)	248 (64.6)	34 (8.9)	3.29
Road surfaces (pavement)	36 (9.4)	69 (18.0)	238 (62.0)	41 (10.6)	3.26
Medians, lane markings, shoulders	36 (9.4)	69 (18.0)	239 (62.2)	40 (10.6)	3.26
Intersections and junctions	41 (10.7)	57 (14.8)	235 (61.2)	51 (13.3)	3.23
Bridges and culverts	29 (7.5)	72 (18.8)	234 (60.9)	49 (12.8)	3.21
Overpasses and underpasses	26 (6.7)	52 (13.5)	270 (70.3)	36 (9.4)	3.18
Road safety features	12 (3.1)	37 (9.6)	267 (69.5)	68 (17.7)	2.98
Bus stops and terminals	10 (2.6)	27 (7.0)	136 (35.4)	211 (54.9)	2.57

Source: Fieldwork (2025). Ratings: very good (5) to very poor (1); no component attracted a very poor rating.

Ranking by mean score clarifies the structure of the deficit (Figure 4). The five highest-rated components are road signage (3.39), traffic management systems (3.34), drainage (3.34), pedestrian crossings (3.33) and streetlights (3.29). These are support elements rather than core carriageway assets. The two lowest are road safety features (2.98) and bus stops and terminals (2.57), the only components falling below the neutral midpoint. Ancillary operational features are thus fairly functional while the facilities on which commercial transport most directly depends are not.

Interview evidence corroborated and extended this ranking. Respondents characterised the network as mixed. One stakeholder observed that although some main roads were in good condition, many others, particularly in inner-city and peripheral areas, suffered

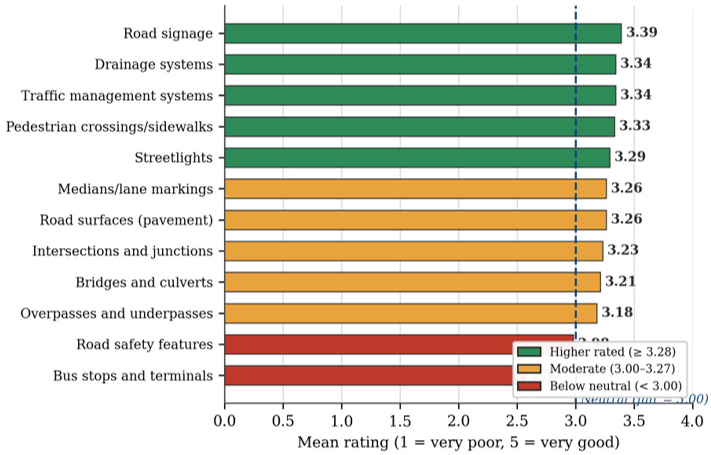

Figure 4: Mean ratings of road transport infrastructure components in Kano Municipality.
Source: Fieldwork(2025).

potholes, poor maintenance, defective drainage and congestion. Another stated flatly that infrastructure was poor on collector and access roads. Road rehabilitation and maintenance, drainage and signage recurred across the majority of interviews as the most pressing needs, followed by traffic management and street lighting, mirroring the quantitative ranking. The route-by-route checklist confirmed both the overall assessment and its spatial variation. Of 26 corridors inspected, arterial routes including Airport Road, IBB Way, Wudil Road and Kundila Zaria Road recorded good to very good conditions across most elements. Inner and residential roads, particularly in the Unguwa Uku axis, recorded fair to poor conditions. Ashton Road, Kofar Mazugal, Dunni Street, Unguwa Uku Old Park and Unguwa Uku Yan Kifi were in very poor condition. Drainage was consistently deficient, signage and traffic control devices were absent on many routes, and pedestrian facilities and bus stops were poorly developed throughout. Figure 5 shows a section of Ahmadu Bello Road with smooth surfacing, clear markings and functioning street lighting, while Figure 6 shows an untarred road at Unguwa Uku Filin Kashew strewn with solid waste. The contrast between the two is the contrast between corridors.

Stakeholders attributed this variation to differences in government investment, maintenance priority, population density, planning history and economic activity between districts. One noted that intercity and major roads were superior to the feeder roads serving neighbourhoods; another observed that most parts of the city fell short

Figure 5: A section of Ahmadu Bello Road showing effective road infrastructure with smooth surfacing, clear markings and street lighting.
Source: Fieldwork (2025).

Figure 6: An untarred road at Unguwa Uku Filin Kashew littered with solid waste.
Source: Fieldwork (2025).

of the standard achieved in Nassarawa GRA; a third contrasted the substandard conditions in Ungogo and Dala with the better provision in Nassarawa, Tarauni and Municipal. A fourth acknowledged government commitment to corridors such as Lodge Road, Sokoto Road and Zoo Road while noting that outlying areas required attention. Taken together, these accounts suggest that the current investment pattern is widening rather than narrowing spatial inequality in the metropolis.

Inferential analysis and key findings

Respondents were broadly positive about the benefits that adequate infrastructure delivers. Increased coverage and accessibility attracted the highest mean (4.31), followed by reductions in waiting time, travel time and cost (4.30), reduced congestion (4.20), improved efficiency and reliability (4.12) and employment creation (4.07). Lower means attached to reduced operating cost through fuel savings and reduced wear (3.90), improved safety (3.80) and increased ridership (3.73), each of which drew a substantial undecided share of between 31.5% and 36.2%. The overall perception is that road infrastructure is beneficial even where actual quality is only moderate.

Interview material grounded these perceptions in operating economics. A stakeholder with more than fifteen years in the Kano transport industry explained the mechanism directly: *"Poor road conditions add fuel costs, requiring more frequent repairs and causing vehicle depreciation, which also adds travel time all of these impact operators' earnings as well as the number of trips they can make in a day."* Others linked infrastructure to livelihood and fares, noting that good roads shorten travel time while bad roads lengthen it, raise transport prices and simultaneously provide a livelihood for a large unemployed population. One respondent reduced the relationship to its essentials as the cost arising from time lost to poor roads; another identified safety and travel time as the dimensions through which poor roads exert their cost. These accounts converge with the survey finding that the principal benefits of infrastructure are affordability, time saving, accessibility, congestion reduction and job creation. Service efficiency presents a more equivocal picture (Figure 7). Price affordability recorded the highest mean at 3.81, followed by accessibility (3.59), scale and coverage relative to commuter needs (3.50), reliability (3.47) and door-to-door service (3.27). Weakest were integration with other transport modes (2.64) and travel time (2.86), with waiting time (3.04), comfort (3.06) and convenience (3.07) barely above neutral. Travel time was rated poor or very poor by 37.5% of respondents and modal integration by 50.8%. The commercial transport system is therefore affordable and widely available but weak in service quality, integration and safety: functional, but not efficient.

Interviews reinforced this reading. Accessibility and affordability were repeatedly identified as the system's strengths, one stakeholder noting that tricycles and minibuses are most commonly used because they are affordable, available and able to navigate congested roads. Reservations attached to safety, with another observing

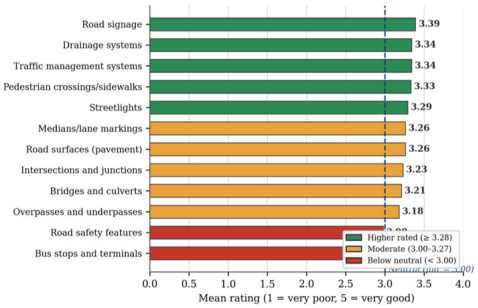

Figure 7: Respondent ratings of commercial transport service efficiency attributes.
Source: Fieldwork (2025).

that tricycles are efficient and affordable but not safe. Waiting times exceeding ten minutes were reported at some locations, and one respondent described the system as suffering over-congestion of tricycles alongside an absence of buses and rail. The characterisation of Kano as dependent on a single mode, with tricycles serving as the major and effectively the only means of movement, explains the very low integration score recorded in the survey. Challenge items produced strong consensus (Figure 8). Insufficient bus stops and terminals recorded the highest mean at 4.31, with 94.8% of respondents agreeing or strongly agreeing and none disagreeing. Inadequate funding for infrastructure investment followed at 4.19 (80.7% agreement), dilapidated infrastructure at 4.07 (77.8%), proliferation of informal modes at 3.99 (76.3%) and disregard for traffic rules by operators at 3.97 (73.9%). High operating costs (3.96), insufficient vehicles (3.80), accident and fatality rates (3.69), poor modal connectivity (3.69) and vulnerability to crime (3.34) followed. These are systemic and structural problems rather than incidental ones, combining infrastructure deficit, financial constraint, weak regulation and informality.

Figure 9 illustrates the terminal deficit that respondents ranked as their foremost concern: a dilapidated and unorganised bus terminal adjacent to the Fagge Jumu'at Mosque, lacking demarcated bays, shelter or passenger facilities. Interview respondents grouped the drivers of these problems into four categories: institutional factors including inadequate planning, weak coordination between transport agencies and insufficient funding;

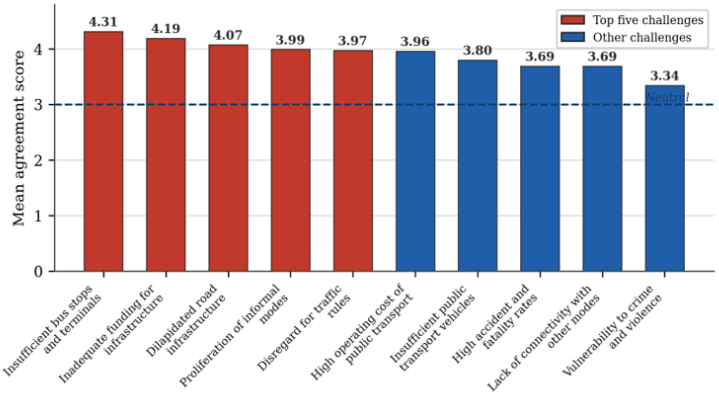

Figure 8: Mean agreement scores for road infrastructure challenges facing commercial transport in Kano Municipality.
Source: Fieldwork (2025).

regulatory factors including weak enforcement of traffic law, vehicle safety standards and transport regulation; financial factors including high fuel prices, limited access to credit for vehicle replacement and inadequate maintenance funding; and behavioural factors including reckless driving, overloading and poor vehicle maintenance practice.

The hypothesis was tested by regressing the commercial transport mode principally used on the twelve rated infrastructure components. The model returned a correlation coefficient of 0.248 and a coefficient of determination of 0.061, with adjusted R^2 of 0.050 and a standard error of 0.736. Infrastructure variables thus account for approximately 6.1% of the variation in mode choice, indicating a weak relationship. The analysis of

Figure 9: A dilapidated and unorganised bus terminal adjacent to the Fagge Jumu'at Mosque, Kano metropolis.
Source: Fieldwork (2025).

variance nonetheless returned F = 5.377 with p < 0.001 on 12 and 380 degrees of freedom, so the null hypothesis of no relationship is rejected and the alternative accepted (Table 4).

The coefficients reveal a mixed structure of effects (Table 5 and Figure 10). Three components exert significant positive influence: streetlights carry the strongest effect (β = 0.154, p < 0.001), followed by overpasses and underpasses (β = 0.126, p = 0.006) and medians, lane markings and shoulders (β = 0.117, p = 0.008). Two exert significant negative influence: road surfaces (β = −0.178, p < 0.001) and road signage (β = −0.119, p = 0.019).

Table 4: Regression model summary and analysis of variance

Statistic	Value	Statistic	Value
R	0.248	Sum of squares (regression)	34.918
R^2	0.061	Sum of squares (residual)	534.086
Adjusted R^2	0.050	Sum of squares (total)	569.004
Std. error of estimate	0.736	df (regression, residual)	12, 380
Mean square (regression)	2.910	F	5.377
Mean square (residual)	0.541	Significance	0.000

Source: Fieldwork (2025). Dependent variable: commercial transport mode principally used.

Drainage is marginal (β = −0.072, p = 0.062) and may attain significance under further investigation. Traffic management systems, road safety features, bus stops and terminals, pedestrian crossings, and bridges and culverts were non-significant.

Two features of this result warrant comment. First, the significant positive predictors are all elements that extend the usable capacity or operating hours of the network rather than merely resurfacing it: lighting permits safe operation after dark, grade separation removes conflict at intersections, and lane discipline raises throughput on a given carriageway. Second, the negative coefficients on road surfaces and signage are best read in light of the

Table 5: Regression coefficients for road infrastructure components

Predictor	B	Std. error	Beta	t	Sig.
(Constant)	1.523	0.097	–	15.744	0.000
Streetlights	0.116	0.032	0.154	3.587	0.000
Overpasses and underpasses	0.093	0.034	0.126	2.757	0.006
Medians, lane markings, shoulders	0.083	0.031	0.117	2.656	0.008
Bus stops and terminals	0.039	0.038	0.053	1.031	0.303
Bridges and culverts	0.003	0.031	0.004	0.099	0.921
Pedestrian crossings and sidewalks	−0.003	0.029	−0.004	−0.107	0.915
Road safety features	−0.007	0.039	−0.009	−0.190	0.849
Traffic management systems	−0.019	0.031	−0.026	−0.623	0.533
Drainage systems	−0.057	0.031	−0.072	−1.871	0.062
Road signage	−0.087	0.037	−0.119	−2.357	0.019
Road surfaces (pavement)	−0.134	0.030	−0.178	−4.490	0.000

Source: Fieldwork (2025). Dependent variable: commercial transport mode principally used.

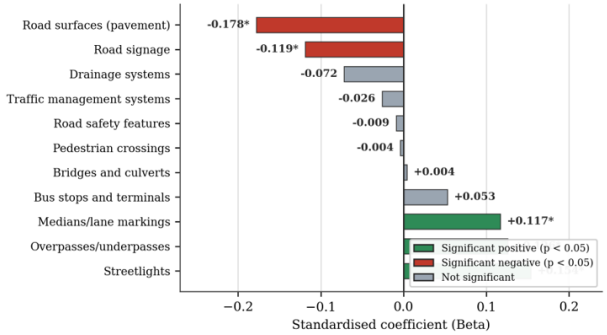

Figure 10: Standardised regression coefficients for road infrastructure predictors of commercial transport mode choice.
Source: Fieldwork (2025).

dependent variable, which measures mode choice rather than service quality. Where surfacing and signage are better, respondents shift away from tricycles toward taxis and minibuses; where they are worse, tricycle dependence deepens. The negative sign therefore records substitution between modes rather than any deterioration of service, and reinforces the finding that tricycles function as the mode of last resort on degraded corridors. The low explanatory power is itself substantively informative. If infrastructure attributes account for only 6.1% of variation in mode choice, the greater part of that variation must be attributed to factors outside the model, principally the socio-economic characteristics of users and the cost and affordability of the available modes. Given that 74.7% of respondents earn below ₦140,000 monthly, fare levels plausibly dominate infrastructure quality in shaping everyday travel decisions. The finding qualifies rather than contradicts the broader literature on the returns to transport investment: infrastructure matters, and its effect is statistically robust, but in a low-income setting with a single dominant informal mode it operates alongside affordability constraints that no amount of resurfacing alone will relieve.

Implications for transport planning and policy

The results identify infrastructure deficits with direct planning consequences. Bus stops and terminals were the lowest-rated component (2.57) and the highest-ranked challenge (4.31), yet they are precisely the assets that allow orderly boarding, defined routes and eventual introduction of scheduled services. Their absence sustains the informal, on-demand operating pattern that respondents simultaneously depend upon and criticise. Investment in terminals and stops is therefore not an amenity but a precondition for any transition toward organised commercial transport, and Kano's low integration score of 2.64 will not improve while transfer points remain undeveloped. The spatial evidence carries an equity implication. Arterial corridors such as Airport Road and IBB Way rate good to very good while inner and peripheral roads in the Unguwa Uku axis rate poor, and stakeholders report that current investment reinforces this gradient. An equity-focused, zonal approach to allocation would direct resources toward underserved districts, reducing disparities in access, travel time and cost. Because low-infrastructure neighbourhoods are also those with weakest access to markets, healthcare, education and banking, correcting the transport gradient carries socio-economic returns extending well beyond mobility itself (Anjorin, 2024; Usman, 2024). Fiscal commitment appears inadequate to the scale of need. The 2.22% of the 2025 Kano State budget allocated to road transport sits well below what closing the documented deficit would require, and 80.7% of respondents identified inadequate funding as a challenge. Raising the allocation and supplementing it through Public-Private Partnerships, a model endorsed by nearly all key informants, offers a route to the necessary investment. One stakeholder observed that with sound policy and a supportive operating environment such partnerships would represent a better option for transport in Kano; another emphasised that collaboration between government agencies, transport unions, private investors and community stakeholders is a prerequisite for an efficient system. Stakeholders converged on five intervention themes. Infrastructure rehabilitation and expansion drew near-universal support, including preventive maintenance, pothole repair, drainage improvement, dualisation of heavily trafficked corridors and separation of commercial from private vehicle lanes. Investment in mass transit and modal alternatives was urged by several respondents, encompassing regulated bus services on designated routes, modern parking provision and revival of rail with a strategic plan. Stronger regulation, training and enforcement were emphasised through proper training of tricycle operators, demarcated lanes, traffic law enforcement, closed-circuit television at conflict points, and public awareness campaigns on road safety. Policy reform and financial support were sought through review of existing policy, substantial investment, affordable credit for vehicle replacement and clear regulatory frameworks. Public-Private Partnership was proposed as the delivery mechanism across all four. These priorities align closely with Transit-Oriented Development principles. Concentrating development around transit nodes, ensuring density sufficient to support scheduled services, diversifying land use around those nodes and designing for pedestrian access and seamless transfer would together address the integration deficit that this study identifies as the system's weakest attribute (Cervero & Kockelman, 1997; Yen *et al.*, 2024). Applied to Kano, the framework directs attention away from continuous carriageway expansion and toward optimising the existing network through dedicated bus lanes, walkways, cycling provision and properly designed stops. The regression finding that lighting, grade separation and lane discipline outperform resurfacing as predictors lends empirical support to that reorientation. Policy attention must nonetheless extend beyond physical works. The weak explanatory power of the infrastructure model indicates that affordability and socio-economic circumstance shape mode choice more powerfully than pavement quality. Regulated fare structures, targeted subsidies for low-income passengers and route-specific pricing reform would address the demand side that infrastructure investment alone cannot reach. Combining such measures with capital works offers a more plausible route to improved commercial transport efficiency than either pursued in isolation.

CONCLUSION

Road transport infrastructure in Kano Municipality is best characterised as fair in aggregate but structurally deficient where it matters most for commercial transportation. Support elements including signage, traffic management, drainage, pedestrian crossings and

street lighting were rated adequate, while bus stops and terminals fell well below the neutral threshold and road safety features approached it. The network is markedly uneven: arterial corridors are well maintained while inner-city and peripheral roads are degraded, and stakeholder testimony indicates that prevailing investment patterns are widening rather than narrowing this gap. Dependence on commercial transport is near-universal, with three-quarters of respondents travelling daily and more than two-thirds relying on tricycles, and no respondent reported access to large-bus services. Infrastructure exerts a statistically significant but empirically weak influence on commercial transport, explaining approximately 6% of variation in mode choice. Street lighting, grade separation and lane markings emerged as significant positive predictors, indicating that assets extending usable capacity and operating hours matter more than resurfacing alone. The resulting system is affordable and widely accessible yet slow, uncomfortable, poorly integrated and mono-modal, functional in the sense that it moves people but inefficient in almost every dimension of service quality. Insufficient terminals, inadequate funding, dilapidated infrastructure, unregulated informal operation and weak traffic discipline constitute the dominant constraints. The study concludes that existing road infrastructure cannot meet prevailing demand, placing substantial strain on assets already in decline. Increased and sustained investment is required, directed particularly toward bus stops, terminals and transfer facilities, and delivered where necessary through Public-Private Partnership. Allocation should follow an equity-focused zonal logic that reduces rather than reproduces spatial disparity. Formalisation and regulation of commercial operators, strengthened enforcement and operator training would address the behavioural and regulatory dimensions, while fare regulation and targeted support would address the affordability constraint that infrastructure investment alone cannot relieve. Adoption of Transit-Oriented Development principles offers a coherent framework for integrating these measures. The findings are limited to Kano Municipality and to perceptual measures gathered at a single point in time, and further research employing longitudinal designs and objective performance metrics would strengthen the evidence base for investment decisions in comparable Nigerian cities.

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