

ASSESSMENT OF THE IMPACT OF ROAD CONSTRUCTION ON RESIDENT COMMUNITIES ALONG NNAMDI AZIKIWE WAY BYPASS, KADUNA

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ABSTRACT

This study examines the impact of road construction along the Nnamdi Azikiwe Bypass in Kaduna metropolis, Nigeria, with emphasis on residents' mobility, access to essential services, and socio-economic conditions. The study is motivated by the increasing urban expansion and ongoing infrastructural development within Kaduna, which often generates both developmental benefits and temporary disruptions to urban life. The study adopted a descriptive research design combining both quantitative and spatial (GIS) approaches. A total of 150 respondents were selected using a stratified random sampling technique. Primary data were collected through structured questionnaires, key informant interviews (KII), field observations, and GPS-based spatial mapping; secondary data were obtained from relevant literature, government reports, and institutional publications. Data were analyzed using descriptive statistics (frequency and percentages) and GIS, ArcGIS Pro 3.5 for settlement mapping and traffic hotspot identification. Findings from the study revealed a linear pattern of residential settlement distribution along the Bypass, with higher population density in areas such as Bakin Ruwa/Rigasa, Sabon Gari, Kakuri, and Unguwan Sanusi. Traffic analysis showed significant congestion hotspots concentrated in these densely populated and economically active areas. The study further revealed that road construction has significantly reduced access to essential services, including workplaces, markets, schools, and healthcare facilities, mainly due to increased travel time, road diversions, and congestion. In addition, the economic assessment indicated increased transportation costs, reduced income, lower productivity, and disrupted business activities among residents during the construction period. The study concludes that while road construction is essential for long-term urban development, it can have significant short-term negative impacts on mobility, accessibility, and socio-economic wellbeing if not properly managed. It recommends improved traffic management strategies, better construction planning, provision of alternative routes, and enhanced stakeholder coordination to minimize disruptions during infrastructure development.

Keywords: Road construction, mobility, accessibility, traffic congestion, socio-economic impact, hotspot analysis, Kernel Density Estimation (KDE), Infrastructure, Linear settlement.

INTRODUCTION

Road networks are widely recognized as foundational infrastructure that link dispersed settlements, economic activities,

and social spaces, thereby enabling the movement of vehicles, commuters, pedestrians, livestock, goods, and services across space (World Bank 1994; Laborda & Sotelsek, 2019). Consequently, roads constitute a pivotal driver of socio-economic development in both rural and urban areas by reducing transport costs, improving market access, and facilitating integration into wider regional and national economies (Straub, 2008; World Bank, 2019). As such, conditions and availability of roads are widely used as indicators and yardsticks for measuring the level of development among geographic entities.

From a global perspective, several studies have documented the multifaceted impacts of road and construction projects on surrounding communities. For instance, Welde and Tveter (2021), in a study of 10 road investment projects in Oslo, Norway, investigated the effects of road investments in secondary markets, conceptualized as wider local impacts, using four indicators: commuting patterns, population change, firm creation, and employment levels. Çelik and Budayan (2016), in residential neighborhoods in Istanbul, Turkey, examined road construction and reported that disruptions to livelihoods, loss of peace, reduced cleanliness of dwellings, and degradation of ambient environmental conditions were among the most disturbing nuisances experienced by residents.

Regional studies on highway and corridor projects have shown that corridors can foster regional integration and trade, while also producing negative effects such as local social dislocation, land-use conflicts, and uneven impacts on indigenous and rural communities along the route (Redwood, 2012; Donaldson, 2018; Kahangirwe & Vanclay, 2024). Studies in peri-urban Kisumu in Kenya and Accra in Ghana have demonstrated that new road infrastructure can improve accessibility, stimulate residential development, and create employment opportunities, but also trigger gentrification, displacement of low-income groups, and widening social inequalities (Acheampong & Siiba, 2022).

Local perspectives highlight Nigerian cities such as Lagos, Abuja, Port Harcourt, and Kano as reporting persistent issues such as project delays, cost overruns, poor artistry, and episodic implementation, all of which erode the anticipated benefits of improved accessibility, safety, and neighborhood livability (Mahmud et al., 2021). These shortcomings often result in prolonged disruption of mobility, increased congestion along construction corridors, elevated safety risks, and a gradual decline in public confidence in infrastructure programs.

This study adopted a descriptive mixed-methods approach, combining questionnaire surveys, field observations, GPS mapping, and ArcGIS-based spatial analysis to examine both

residents' lived experiences and the spatial distribution of traffic congestion and accessibility constraints. Prior research shows that road projects often generate significant construction-phase disruptions such as reduced business patronage, longer travel times, higher transport costs, and restricted access to services, while GIS methods help identify where such effects cluster most intensely (Ogunseye et al., 2020; Al-Amri et al., 2021; Hossain & Hossain, 2020; Kahangirwe & Vanclay, 2024).

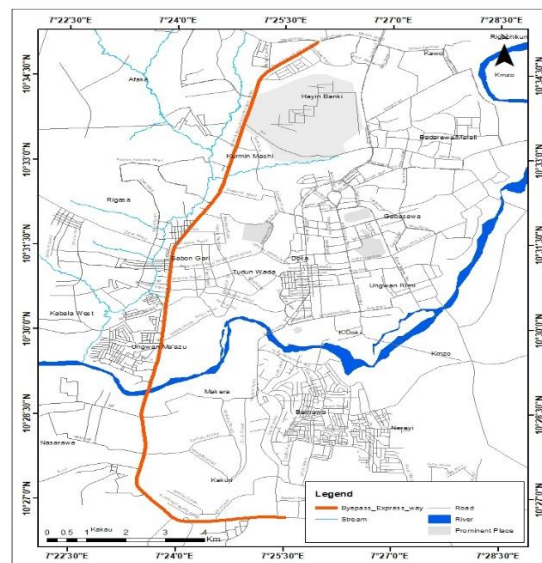
Despite the growing national and regional literature on the socio-economic implications of road infrastructure, there is still limited corridor-specific empirical evidence on how the Nnamdi Azikiwe Way Bypass in Kaduna reshapes everyday mobility, livelihoods, environmental conditions, and quality of life for resident communities to the best of the researcher's knowledge.

This study assesses the impact of road construction along Nnamdi Azikiwe Way Bypass, Kaduna Metropolis, on resident communities between 2025-2026, employing a combination of quantitative and qualitative research designs. The study is therefore guided to provide answers to the following formulated objectives:

- To identify and map the communities most affected by the road construction project along Nnamdi Azikiwe Way Bypass, Kaduna.
- To identify and analyze the spatial distribution of traffic congestion and road traffic accident hotspots along the study route.
- To assess the socio-economic impacts of the road construction project on the residents of the affected communities.

Study Area

The Nnamdi Azikiwe Way Bypass is located in Kaduna metropolis, Nigeria, and extends approximately 21.5 km in length (Federal Ministry of Works, 2024; Google Earth Pro, 2026). The southern terminus is at Command Junction, located at latitude 10°26'40.46" N and longitude 7°25'25.14"E, while the northern terminus is at Mando Roundabout, located at latitude 10°35'6.44" N and longitude 7°25'57.02"E. The study area is characterized by two distinct seasons: a wet season (April to October) and a dry season (November to March). The relief of the area is largely flat to gently undulating terrain, drained by streams and surface runoff into River Kaduna, which crosses at Nassarawa, Kudenda, and Unguwar—muazu communities (World Meteorological Organization, 2023; Nigerian Meteorological Agency, 2024).



Source: Adapted and modified from KADGIS (2026)

Figure 1: Kaduna Metropolis Showing Nnamdi Azikiwe Way Bypass

MATERIAL AND METHODS

This section discusses the materials and methods required for the study.

Types and sources of data

The study used both primary and secondary data. Primary data included GPS coordinates collected through field survey, field observations obtained through direct observation, questionnaires administered to residents of the affected communities and other stakeholders, and key informant interviews (KII) conducted with government officials, community leaders, and project representatives. Secondary data were obtained from administrative maps supplied by the Kaduna Geographic Information Service (KADGIS), boundary shapefiles sourced from GRID3, OpenStreetMap (OSM), and Google Earth Pro, published literature drawn from peer-reviewed journals, books, reports, newspapers, and periodicals, as well as government reports obtained from the Federal and State Ministries of Works, the Federal Road Safety Corps (FRSC), and the Kaduna State Traffic Law Enforcement Authority (KASTLEA).

Data validation

The validity and reliability of both primary and secondary data were carefully ensured throughout the study. The reliability of the questionnaire was assessed using a Cronbach's alpha of 0.70, confirming the instrument was sufficient for data collection, and triangulated by comparing KIIs to reduce bias. GPS coordinates collected were validated using vector boundary files from KADGIS, GRID3, and OpenStreetMap (OSM), with a satellite image from Google Earth Pro.

Data preprocessing

All primary and secondary datasets were systematically preprocessed before analysis. Completed questionnaires were screened for completeness, consistency, and legibility. Qualitative data obtained from KIIs were organized into themes and reviewed

for consistency and content analysis. GPS coordinates were projected to the Universal Transverse Mercator (UTM) coordinate system (WGS 84, Zone 32N) for analysis; attribute data were checked for errors and consistency before input.

Sampling Technique

The study used stratified random sampling to ensure representation of household heads, traders, transport operators, and commuters affected by the Nnamdi Azikiwe Western Bypass project. Ward-level projected populations from 2023 (Kaduna State Bureau for Statistics) were used as the sampling frame, and a sample of 150 respondents was determined using Yamane's (1967) formula at a 95% confidence level and 5% margin of error (Muhammad et al., 2024). Questionnaires were then allocated in proportion across wards and stakeholder groups to improve representativeness and reliability (Appendix I).

$$n = \frac{N}{1 + N(e)^2}$$

Where: n = Sample size, N = Total population, e = Margin of error (level of precision), usually 0.05 for a 95% confidence level.

Ethical Consideration

The study followed approved ethical procedures, with informed consent obtained from all participants, voluntary participation ensured, and confidentiality protected through anonymity. Ethical clearance and the necessary permissions were obtained before the commencement of fieldwork. All secondary sources were appropriately acknowledged, while geospatial data, including GPS coordinates and maps, were handled carefully to protect privacy and minimize potential security risks.

Data Analysis

The methods of data analysis adopted for this study were aligned with the research questions as follows:

Objective 1: To identify and map the communities most affected by the road construction project along Nnamdi Azikiwe Way Bypass, Kaduna.

GPS coordinates of affected communities collected during the field survey were overlaid as point data on the street network in ArcGIS Pro 3.5. A spatial query was also performed to identify communities located within the zone of influence of the road construction activities. Structured Query Language (SQL), particularly the "query by location" algorithm in ArcGIS Pro 3.5, was used to identify the communities that are "completely within" a 1 km buffer from the sides of the Bypass. The output results for this analysis were presented as a map showing the location and distribution of settlements along the corridor (Figure 2).

Objective 2: To identify and analyze locations with traffic congestion hotspots along the study route.

Traffic data for each of the major junctions along the corridor were obtained through field surveys over the period of one month; this is also validated by KII and questionnaire responses (Appendices I, II & III). Location information from KII and questionnaires was geocoded and integrated with traffic data. The data were analyzed using the Kernel Density Estimation (KDE) tool from ArcGIS Pro 3.5 to determine point concentration and clusters of traffic congestion (hotspots) along the study corridor. The results were displayed on a map (Figure 2), showing areas of "high", "moderate,"

and "low" concentration in red, yellow, and blue, respectively.

Objective 3: To assess the socio-economic impacts of the road construction project on the residents of the affected communities.

Data from the questionnaires were analyzed using descriptive statistics in SPSS version 26. Frequency counts and percentages summarized respondents' perceptions of the socio-economic impacts of the road construction project, including changes in accessibility to workplaces, markets, schools, and healthcare facilities, as well as effects on transportation costs, household income, business activities, and productivity. Findings are presented in tables that display frequency (n) and percentage (%) distributions, providing a concise depiction of the project's socio-economic effects on residents of the affected communities.

RESULTS

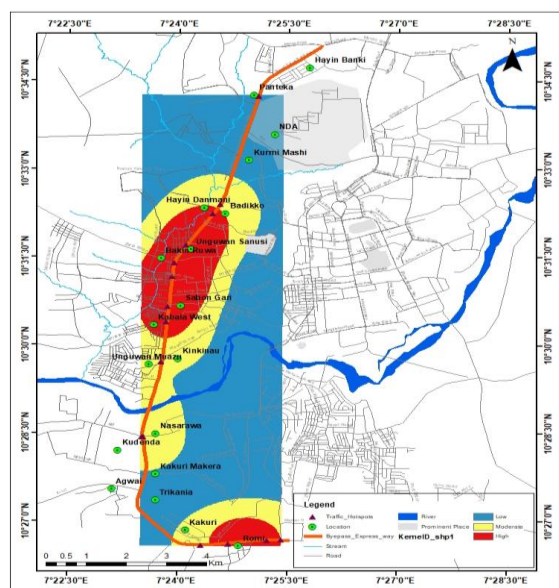
Findings from the analysis of the objectives using a quantitative and qualitative approach.

Identification and Mapping of Communities Most Affected by the Road Construction

Settlement patterns along the corridor exhibit a predominantly linear configuration according to the GIS-based analysis. The results identified 18 settlements that fall within the areas of high impact, which include: Hayin Banki, the Nigerian Defense Academy (NDA), Kurmin Mashi, Badikko, Ungwan Sunusi, parts of Sabon Gari/Tudun Wada, Kinkinau, Nassarawa, Trikania, and Kakuri, which are located on the eastern flank of the Bypass, while Ungwan Romi, Abuja Junction, Agwa, Kudenda, Ungwan Muazu, Kabala West, Hayin Malam Bello, Bakin Ruwa/Rigasa, Ung. Sanusi, Hayin Dan-Mani, and Mahuta communities are on the western side as shown in Figure 2.

Spatial Distribution of Traffic Hotspots along the Road

The results reveal concentration of traffic hotspots around communities with significant population density, bustling commercial activity, dynamic land use, and convergence of major feeder roads. Analysis identified Kabala West Junction, Hayin Mallam Bello, Bakin Ruwa/Rigasa, Ung. Sanusi and Romi Junction as "high" hotspots, and Ung. Muazu, Kudenda, Nassarawa, and Agwa Junction as "moderate". NDA, Panteka, Kurmin Mashi, and Trikania were classified as "low," as depicted in Figure 2. Findings corroborated reports from Punch Newspaper (2026) and Daily Trust (2026) capturing outcry and protests from resident communities, commuters, and business owners in that axis. It is also supported by Downs' (2004) theory of traffic congestion, which postulated that traffic congestion in urban environments is often concentrated around economic centers and densely populated residential areas. Table 2 shows the number and location of accidents over the study period.



Source: Author's Analysis (2026)
Figure 2: Study Area Showing Traffic and Accident Hotspots

Socio-economic Impacts of the Road Construction Project on the Residents of the Affected Communities

An assessment of the socioeconomic impact of the project on resident communities was conducted, highlighting residents' access to essential services and economic implications for their livelihood.

Accessibility to Essential Services

Table 1 presents respondents' assessment of access to essential services before and during the road construction along the Nnamdi Azikiwe Way Bypass.

Table 1: Assessment of Accessibility Indicators

Accessibility Indicator	Response Category	Frequency (n)	Percentage (%)
Workplace Accessibility (Before Construction)	Very Easy	58	38.7
	Easy	47	31.3
	Difficult	28	18.7
	Very Difficult	17	11.3
	Total	150	100.0
Workplace Accessibility (During Construction)	Very Easy	12	8.0
	Easy	26	17.3
	Difficult	63	42.0
	Very Difficult	49	32.7
	Total	150	100.0
Market Access	Longer travel time	58	38.7
	Higher	41	27.3

School Access	transport cost		
	Reduced	26	17.3
	transport availability		
	Others	25	16.7
	Total	150	100.0
	Delays	52	34.7
	Increased	31	20.7
Healthcare Access	transport cost		
	Safety concerns	18	12.0
	No issue	49	32.6
	Total	150	100.0
	No effect	29	19.3
	Slight delay	46	30.7
	Serious delay	44	29.3
	Very difficult to access	31	20.7
	Total	150	100.0

Source: Field Survey (2026)

Workplace accessibility

The findings revealed that before construction, 58 respondents (38.7%) described access to their workplaces as “very easy”, while 47 respondents (31.3%) considered it “easy”. This indicates that 70.0% of respondents experienced relatively convenient commuting conditions. However, during construction, only 12 respondents (8.0%) reported “very easy” access, while 26 respondents (17.3%) indicated “easy access”. 63 respondents (42.0%) and 49 respondents (32.7%) reported “difficult” and “very difficult” access, respectively. Overall, 112 respondents (74.7%) experienced difficulty accessing their workplaces during the construction period, demonstrating that construction activities substantially disrupted daily commuting, aligning with studies by Duranton and Turner (2012a) and Foster et al. (2023).

Market accessibility

The findings indicate that the most commonly reported challenge was longer travel time, identified by 58 respondents (38.7%). This is followed by higher transportation costs (41 respondents; 27.3%), reduced transport availability (26 respondents; 17.3%), and other challenges. Traffic congestion and road blockages were reported by 25 respondents (16.7%). These findings suggest that construction activities have increased both the time and financial costs of market participation, thereby affecting trading activities and household livelihoods (Ikioda 2016, World Bank 2020).

School accessibility

A total of 87 respondents (58.0%) indicated that school accessibility had been affected, while 63 respondents (42.0%) reported no significant impact. Among the reported challenges, delays in commuting constituted the most common problem (52 respondents; 34.7%),

followed by increased transportation costs (31 respondents; 20.7%) and safety concerns (18 respondents; 12.0%). Nevertheless, 49 respondents (32.6%) experienced no major challenges. Findings are consistent with those of Vanclay et al. (2024), emphasizing that inadequate management of social impacts during road construction frequently exposes schoolchildren to increased traffic hazards and restricts safe pedestrian movement.

Economic Impacts of Road Construction on Residents

Table 2 presents respondents' assessment of the economic impacts of the road construction along the Nnamdi Azikiwe Way Bypass.

Economic Implications

This section examines the economic effects of the road construction on residents, with particular focus on transportation costs, income, and productivity.

Table 2: Economic Indicators

Indicator	Response Category	Frequency (n)	Percentage (%)
Transportation Cost	Increased significantly	57	38.0
	Increased slightly	49	32.7
	No change	28	18.7
	Decreased	16	10.6
	Total	150	100.0
Effect on Income/Business	Yes	94	62.7
	No	56	37.3
Type of Economic Impact	Total	150	100.0
	Reduced customers	46	30.7
Effect on Productivity	Late arrival to work	33	22.0
	Reduced working hours	21	14.0
	No impact	50	33.3
	Total	150	100.0
	Strongly affected	66	44.0
	Moderately affected	34	22.7
	Slightly affected	23	15.3
	Not affected	27	18.0
	Total	150	100.0

Source: Field Survey (2026)

Transportation costs

The findings revealed that the majority of respondents (106; 70.7%) reported an increase in transportation costs during the road construction period. Of these, 57 respondents (38.0%) experienced a significant increase, while 49 respondents (32.7%) reported a

significant increase (Table 3). Conversely, 28 respondents (18.7%) observed no change, while only 16 respondents (10.6%) reported a reduction in transportation costs. The increase can be attributed to prolonged travel times, traffic congestion, road diversions, increased fuel consumption, and higher transport fares charged by commercial vehicle operators to offset delays and additional operating costs.

Effect on income and business

Overall, 94 respondents (62.7%) indicated that the road construction had negatively affected their income or business activities, while 56 respondents (37.3%) reported no noticeable effect. These findings suggest that restricted accessibility and increased travel costs reduced business transactions, disrupted work schedules, and limited opportunities for income generation, particularly among traders, transport operators, artisans, and workers whose livelihoods depend on daily mobility. These findings are consistent with Weisbrod (2008) and Duranton and Turner (2012b), who reported that work-zone traffic disruptions substantially increase travel time and vehicle operating costs for road users.

Type of economic impact

Among respondents who experienced economic challenges, the most frequently reported impact was reduced customer patronage, identified by 46 respondents (30.7%). This was followed by late arrival to work, reported by 33 respondents (22.0%), while 21 respondents (14.0%) experienced reduced working hours. However, 50 respondents (33.3%) indicated that the road construction had no direct economic impact on their livelihoods. The findings suggest that road construction disrupted commercial activities by reducing customer accessibility, increasing commuting time, and limiting productive working hours, thereby affecting household livelihoods and business performance, aligning with Ikioda (2016).

Effect on productivity

The findings reveal that 66 respondents (44.0%) reported that their productivity was strongly affected, while 34 respondents (22.7%) indicated a moderate effect. Additionally, 23 respondents (15.3%) experienced a slight reduction in productivity, whereas only 27 respondents (18.0%) reported no effect. Overall, 100 respondents (66.7%) reported experiencing between moderate and severe productivity losses during the construction period. These declines can largely be attributed to increased commuting time, frequent traffic congestion, road diversions, travel uncertainty, fatigue, and reduced effective working hours, all of which negatively influenced workers' efficiency and business performance (Weisbrod, 2008).

DISCUSSIONS

Findings from this study demonstrate that road construction along the Nnamdi Azikiwe Way Bypass has generated substantial short-term disruptions to residents' accessibility and socio-economic wellbeing. Accessibility to workplaces, markets, schools, and healthcare facilities deteriorated considerably during the construction period, with the most severe effects observed in access to healthcare (80.7%) and workplaces (74.7%).

The observed decline in accessibility is consistent with previous studies showing that road construction temporarily reduces network efficiency and increases travel delays before the long-term benefits of infrastructure improvements are realized (Duranton &

Turner, 2012a; Foster et al., 2023). Similar findings have been reported in rapidly urbanizing cities where inadequate traffic management during construction resulted in increased congestion and reduced access to employment, education, healthcare, and commercial centers (Datta, 2012).

The study further reveals that the accessibility challenges translated directly into economic losses for residents. More than two-thirds of respondents (70.7%) experienced increased transportation costs, while 62.7% reported adverse effects on their income or business activities. Reduced customer patronage, workplace lateness, and diminished productivity emerged as the principal economic consequences, reflecting the dependence of local livelihoods on efficient transportation systems.

Finally, the findings underscore the need to incorporate comprehensive social impact mitigation measures into road construction projects. Construction planning should prioritize traffic management, continuous stakeholder engagement, pedestrian safety, and the provision of alternative transport routes to minimize temporary accessibility constraints and economic losses while ensuring that the anticipated long-term benefits of road infrastructure development are realized.

Conclusions

The road construction along Nnamdi Azikiwe Way Bypass has had substantial short-term negative effects on residents' accessibility and socio-economic wellbeing. Nevertheless, these impacts are likely to be temporary and may be offset by the long-term benefits of improved road infrastructure upon project completion. The findings therefore highlight the need for road construction projects to incorporate comprehensive traffic management plans, alternative access routes, stakeholder engagement, and effective social impact mitigation measures throughout the construction phase. Such measures would reduce temporary disruptions, protect local livelihoods, and enhance public acceptance of major infrastructure projects while ensuring that their long-term developmental benefits are fully realized.

Recommendations

Based on the findings from the study, recommendations are focused on improved traffic management strategies, better construction planning, provision of alternative routes, and enhanced stakeholder coordination to minimize disruptions during infrastructure development.

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APPENDIX I

Table Showing Sample Size Allocation for Communities (Yamane, 1964)

S/N	Ward	2023 Projected Population	Communities Covered in the Study	Sample Allocation (n _i)
1	Hayin Banki	104,195	Hayin Banki, NDA axis	22
2	Makera	92,513	Kakuri Industrial Area	20
3	Tudun Nupawa	70,673	Kinkinau, Agwa	15
4	Sabon Gari North	69,460	Sabon Gari	15
5	Badikko	66,715	Badikko, Bakin Ruwa	14
6	Barnawa	63,885	Kabala West, Unguwan Mu'azu	13
7	Tudun Wada South	49,704	Hayin Dan Mani, Hayin Mallam Bello	10
8	Unguwan Sanusi	44,670	Unguwan Sunusi, Kurmin Mashi	9
9	Kabala	45,312	Parts of Kabala	9

10	Tudun Wada North	37,229	West Parts of NDA axis	8
11	Kakuri Gwari	32,616	Parts of Kakuri	7
12	Sabon Gari South	32,774	Southern Sabon Gari	7
13	Televisio n	29,340	Romi, Trikania, Kudenda Corridor	6
14	Kakuri Hausa	28,376	Nassarawa/Kakuri	6
Total		667,462		150

Source: Kaduna State Bureau of Statistics. (2025), Researcher's Analysis (2026)

APPENDIX II

Observed Traffic Congestion Frequency Along the Study Corridor (One-Month Observation)

S/N	Location	Hotspot Category	Number of Congestion Incidents (30 Days)	Average Daily Incidents
1	Kabala West Junction	High	90	3.0
2	Hayin Mallam Bello	High	86	2.9
3	Unguwan Sanusi Junction	High	83	2.8
4	Romi Junction	High	80	2.7
5	Bakin Ruwa (Rigasa) Junction	High	78	2.6
6	Unguwan Mu'azu	Moderate	58	1.9
7	Kudenda Junction	Moderate	54	1.8
8	Nassarawa Junction	Moderate	50	1.7
9	Agwa Junction	Moderate	46	1.5
10	NDA Junction	Low	30	1.0
11	Panteka	Low	27	0.9
12	Kurmin	Low	24	0.8
13	Mashi Trikania Junction	Low	21	0.7
Total			727	24.2

Source: Field Survey (2026)