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AN ASSESSMENT OF STUDENT TRAVEL CHARACTERISTICS AND DISTANCE IMPLICATIONS OF PUBLIC SECONDARY SCHOOLS DISTRIBUTION IN JOS NORTH LGA, NIGERIA

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Abstract https://doi.org/10.65760/sjgs.v4.i2.15

The spatial distribution of public secondary schools can substantially influence students' travel burden and access to education, particularly in rapidly urbanising contexts. This study examines the relationship between distribution of public secondary school and student travel characteristics in Jos North Local Government Area (LGA), Plateau State, Nigeria. A mixed-methods design integrated questionnaire surveys and road-network analysis. Data were collected from 416 administrative wards selected from a sampling frame of 4,300 blocks. Findings indicate that walking is the dominant travel mode (61%), with an average walking time of 31 minutes, while 16% cycle, 13% use private automobiles and 10% use public transport. Although 84% of residential areas fall within a 2-km school proximity buffer, network-based analysis reveals substantial spatial disparities, with average travel distance of 1.5 km and longer journeys concentrated in peripheral wards. The road network exhibits limited connectivity and route alternatives, reflected in Beta and Gamma indices of 0.953 and 0.318, respectively. Travel burden is associated with absenteeism (33%), fatigue (31%) and lateness (31%). Binary logistic regression further identifies a significant relationship between distance to school and enrolment, with a model classification accuracy of 76.3%. The study concludes that proximity-based measures alone inadequately capture educational accessibility. It recommends network-based school planning, prioritisation of underserved areas, improved pedestrian connectivity, safer school-access corridors, and integrated education–transport planning.

Keywords: *School accessibility; Travel distance; School enrolment; GIS network analysis; Spatial mismatch.*

1.0 Introduction

Accessibility remains a central objective of urban planning in both developed and developing countries, encompassing organisational, socioeconomic, and geospatial dimensions (Nyam-Jim, 2016; Solá, Vilhelmson, & Larsson, 2018). Within this framework, geospatial accessibility the time and distance required to reach a service pointcaptures the spatial relationship between facilities, residential areas, and the infrastructure that connects them, and remains a foundational concern for planners seeking to balance land-use and transport systems (Solá et al., 2018).

Proximity to essential services such as schools, healthcare facilities, markets, and security posts is a key determinant of urban socioeconomic wellbeing, shaping how equitably residents can participate in social and economic life (Sharma & Patil, 2023). Where school accessibility is poor, the

consequences cascade: enrolment falls, households shift toward costlier private alternatives, literacy outcomes weaken, poverty deepens, and crime risesall of which undermine broader socioeconomic development (Shanmathi, Radhakrishman, & Samson, 2020). The scale of the problem is considerable: the United Nations (2023) warns that, absent urgent intervention, 84 million children globally will remain out of school by 2030, with inadequate physical access to schools identified as a principal driver of this crisis.

In Nigeria, these global challenges are compounded by weak urban planning frameworks, inadequate transport systems, and the politicisation of school-siting decisions, which together produce spatially inequitable school networks (Oloko-Oba et al., 2016). A related and persistent problem is the continued prioritisation of motorised transport infrastructure over the pedestrian needs of schoolchildren, despite the fact that walking remains the dominant mode of school travel in most low- and middle-income urban contexts (Srivastava, Sharma, & Sahay, 2025). In Jos North and across Plateau State more broadly, deteriorating road conditions, the near-total absence of dedicated pedestrian infrastructure, and persistent security concerns continue to constrain schoolchildren's mobility and, by extension, their access to education (Bature & Barki, 2019; Suleiman & Yusuf, 2026). Road safety risks to children are not merely historical: nationally, Nigeria recorded 5,421 road traffic deaths in 2024 alone, with children accounting for a measurable share of fatalities40 boys and 43 girls killed in a single reporting quarterand the Jos–Lafia–Makurdi corridor, which passes directly through Plateau State, ranked among the country's deadliest routes in the same period (Africa Check, 2026). Jos's rugged, dissected terrain and dense network of seasonal rivers add a further, locality-specific hazard: children who must cross flood-prone routes or unbridged waterways on their way to school face elevated risk during the rainy season, a pattern documented in comparable mountainous, developing-country settings where school routes intersect flood zones (Sakamoto, Laudari, Fujioka, et al., 2024).

Recent geospatial evidence indicates substantial disparities in the distribution of public secondary schools in Jos North LGA. Suleiman and Yusuf (2026) reported a population-to-school ratio of 21,800 persons per school, more than twice the recommended benchmark of 10,000 persons per school, with an estimated deficit of 29 schools. Although 84% of residential areas were located within a 2 km radius of a public secondary school, nearest-neighbour analysis revealed a largely random spatial distribution, with some wards comparatively underserved. While these findings establish the spatial imbalance in school provision, they do not adequately explain how this distribution translates into students' actual travel characteristics and distance burdens. In particular, limited evidence exists on students' travel modes, journey distances and times, spatial variations in commuting patterns, and the extent to which school location influences the daily mobility of secondary school students.

This study therefore focuses on the student travel characteristics and distance implications of public secondary school distribution in Jos North LGA. It examines students' travel modes, distances, and journey times to school and assesses how these characteristics vary spatially in relation to the distribution of schools and road-network conditions. By integrating students' reported travel behaviour with GIS-based network analysis, the study moves beyond simple proximity measures to reveal the actual spatial and mobility burdens associated with uneven school provision. The findings provide empirical evidence for more responsive school-siting, pedestrian infrastructure, and transport-planning strategies aimed at reducing excessive student travel distances and improving equitable access to public secondary education.

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2.0 Literature Review

2.1 The Concept of Accessibility

Accessibility is a foundational concept in urban planning and transportation research, broadly defined as the ease with which people can reach essential services and opportunities (van Wee, 2022). Early approaches framed it narrowly in terms of travel time or distance (Cyril, 2020), while more recent scholarship situates it within a wider equity framework accounting for social inclusion and mobility constraints (van Wee, 2022). The concept links land-use decisions with transport systems to ensure that services remain reachable (Solá et al., 2018), and individual-level accessibility is further shaped by personal circumstances internal capacities, external resources, and structural constraints (Dodge & Nelson, 2023).

In education specifically, accessibility spans physical, social, and institutional dimensions, with recent geospatial evidence confirming that infrastructural and locational factors remain the dominant drivers of unequal access to basic educational facilities (Yang et al., 2026). Nyam-Jim (2016) and Solá et al. (2018) similarly classify accessibility into organisational, socioeconomic, and geospatial dimensions, while Tamunoikuronibo and Anthony (2023) identify five core elements of school accessibility proximity, transport factors, socioeconomic status, school quality, and socio-cultural influences though their framework notably overlooks accessibility for learners with disabilities, a gap that remains under-addressed in the Nigerian literature. UNESCO recommends a maximum walking distance of 2 km to secondary schools (Sesugh, Saba, & Oluwafemi, 2023), since longer distances common in rural and peri-urban areas are consistently associated with reduced enrolment (Adeleke & Alabede, 2022; Nwoke, 2024). Cost barriers compound this problem: recent research shows that the further a low-income household lives from a public school, the more likely it is to enrol its children in a low-cost private alternative instead, even where this represents a comparable or greater financial burden (Obiakor, 2025). Key accessibility metrics travel distance and time are themselves shaped by school distribution, road connectivity, and transport policy (Agbabiaka, Aguda, & Nzere, 2020), and enrolment outcomes depend jointly on these spatial metrics and household socioeconomic conditions (Bature & Barki, 2019).

2.2 Travel-Related Challenges and Physical Barriers

The daily school commute carries physical, emotional, and academic costs that are often overlooked in accessibility research. Long or difficult journeys are associated with fatigue and reduced classroom concentration (Mutonhodza, 2025; Bature & Barki, 2019); with weather- and environment-related illness among children who travel through unsheltered conditions, a pattern documented more broadly in Nigerian child-health research (Adesanya & Chiao, 2017); with chronic and seasonal absenteeism as households weigh commuting burden against school choice (Zuilkowski, 2020; Obiakor, 2025); and with lateness where journeys exceed the 2 km accessibility threshold or traverse poorly connected routes (Agbabiaka et al., 2020; Olayede et al., 2022).

Beyond distance itself, the physical environment students must navigate shapes their safety and attendance. In Nigerian urban areas, challenging terrain, conflict with motorists, inadequate pedestrian infrastructure, and insecurity collectively constrain school commutes (Koinange, 2020). Poor walkway surfaces and missing pedestrian infrastructure increase physical exertion and injury risk (Alade, Agunloye, & Ajakaiye, 2022), while the absence of protective infrastructure such as bollards and marked crossings heightens unsafe pedestrian–vehicle interactions (Alade et al., 2022). Comparable neglect of basic pedestrian amenities sidewalks, footbridges, safe crossing points has been documented across Lagos, Abuja, and other major Nigerian cities (Raji, Solanke, & Alli, 2021).

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Insecurity along school routes, including school attacks and abductions concentrated in Nigeria's North-East and North-West, further disrupts learning for millions of children and disproportionately discourages girls' school participation (UNICEF, 2024).

2.3 Distance, Cost, and School Enrolment

The proximity of public schools to students' homes is a key determinant of enrolment and attendance patterns (Adeleke & Alabede, 2022). Where schools are located far from residential areas, particularly in rural or poorly developed regions with limited transport, long commutes discourage enrolment and contribute to dropout (Nwoke, 2024). Commuting costs compound this effect: transport expenses strain low-income households and can push families toward educational exclusion in favour of more immediate priorities, with distance-related costs disproportionately affecting the poor and reinforcing cycles of poverty and restricted mobility (Obiakor, 2025).

Collectively, this literature establishes that school accessibility is multidimensional spanning physical distance, network connectivity, cost, safety, and environmental hazard and that each dimension carries measurable consequences for enrolment and attendance. However, most Nigerian studies assess accessibility through static proximity or buffer measures rather than actual, network-based travel behaviour. This study addresses that gap by combining student-reported travel characteristics with GIS network analysis to evaluate the real, rather than nominal, accessibility of public secondary schools in Jos North LGA.

3.0 Materials and Methods

3.1 Study Area

Jos North is one of the 17 LGAs in Plateau State, Nigeria, located between latitudes 9°50′N–10°00′N and longitudes 8°54′E–9°00′E, covering about 340 km² (Andesikuteb & Lekwot, 2021). Situated on the Jos Plateau at an elevation of 1,238 meters, it features a rugged terrain of hills and valleys that shape its spatial development and limit urban expansion (Lekwot & Andesikuteb, 2014). The difficult topography, combined with poor urban planning and infrastructure, has led to congested settlements and accessibility challenges in wards such as Abba Na Shehu, Ali Kazaure, and Naraguta B. Established in 1991 following the split of the former Jos LGA, Jos North is Plateau State's economic and administrative hub. It includes both urban and peri-urban communities like Naraguta, Tudun Wada, and Jenta Adamu. Originally a Berom settlement, the area grew rapidly after the discovery of tin in 1903, attracting migrants and driving infrastructural development (Henry, 2023).

2.2 Materials and Methods

This study adopted a cross-sectional mixed-methods design integrating primary household-level survey data with secondary spatial data within a Geographic Information Systems (GIS) and statistical analytical framework. The approach was designed to examine the spatial distribution of public secondary schools and its implications for students' actual travel distance, travel time, transport mode, commuting burden, and school enrolment in Jos North Local Government Area (LGA), Plateau State, Nigeria. Primary data were obtained through a structured questionnaire capturing respondents' residential location, travel mode, travel time, travel cost, and commuting challenges. Secondary data comprised public secondary-school locations, cadastral data, satellite imagery, and the road network.

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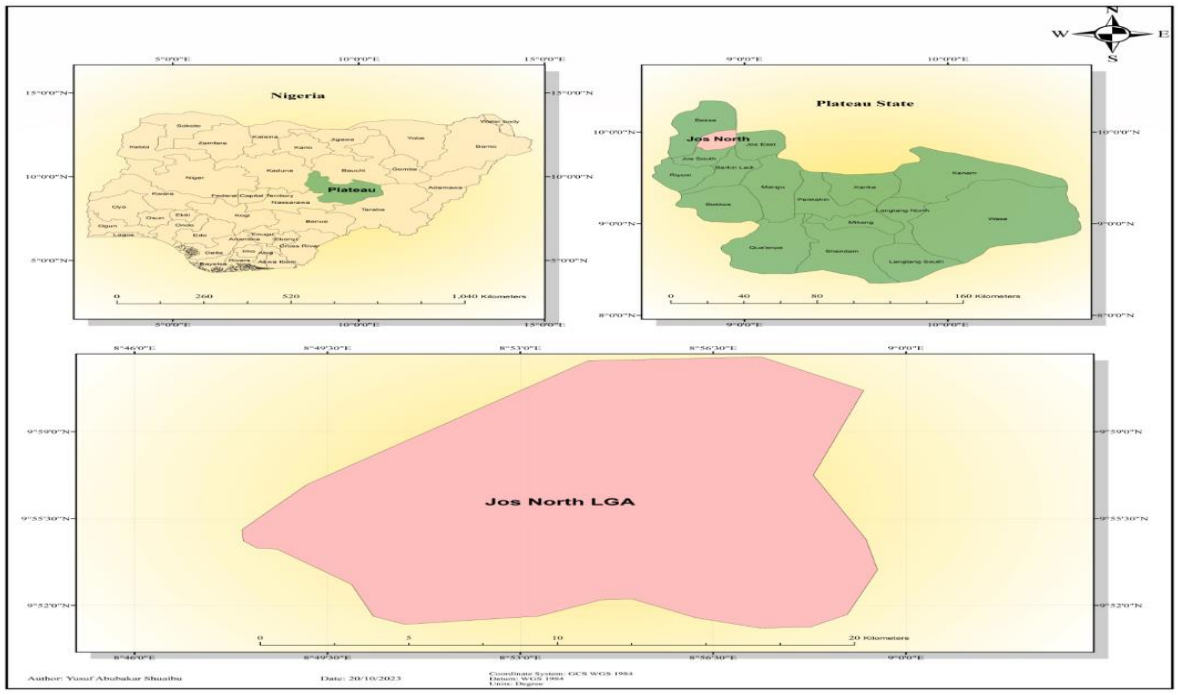

Figure Error! No text of specified style in document.: Locational Map of the Study Area
Source: Digitized from (Google Maps, 2024)

The sampling frame consisted of approximately 4,300 residential blocks obtained from the Ministry of Lands, Survey and Town Planning. The required sample size was determined using the Taro Yamane (1997) formula:

$$n = N / [1 + N(e)^2]$$

where n is the required sample size, N is the population or sampling-frame size and e is the acceptable margin of error (0.05). Thus:

$$n = 4{,}300 / [1 + 4{,}300(0.05)^2] = 365.96 \approx 366$$

Accordingly, 366 residential blocks constituted the target spatial sample. A systematic sampling procedure was employed to select the wards across the administrative boundary of Jos North LGA. The cadastral map of the study area was georeferenced and overlaid on satellite imagery to establish the administrative wards sampling frame and guide field selection. Approximately every 12th residential block was selected according to the housing-numbering sequence, with the sampling interval adjusted where necessary to maintain spatial coverage. Within each selected block, the first eligible household/residence was identified, and secondary-school-age children were targeted for the survey. A total of 452 questionnaires were administered, of which 416 were successfully retrieved and considered valid for analysis, representing a response rate of 92.0%.

Road-network structure was further evaluated using the Alpha (α), Beta (β), and Gamma (γ) indices. The Beta Index was calculated as the ratio of network edges to nodes (E/N), providing an indication of network complexity. The Gamma Index was used to assess the proportion of realised links relative to the maximum possible links in a planar network, while the Alpha Index assessed network

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circuitry. The connectivity results were therefore used primarily to assess route redundancy, network continuity, and their implications for students' actual travel distances and journey times.

Descriptive statistics were used to summarise students' travel modes, travel times, travel costs, commuting challenges, and perceived travel obstacles. Frequencies, percentages, means, and standard deviations were used where appropriate. Travel distances were examined both for the study area as a whole and across wards to identify spatial disparities in accessibility.

Binary logistic regression was employed to examine whether distance to the nearest public secondary school was significantly associated with school enrolment. The dependent variable was coded as a binary outcome, with 1 representing non-enrolment and 0 representing enrolment, while distance to the nearest public secondary school was specified as the principal predictor. The model was expressed as:

$$P(Y = 1 \mid X) = 1 / [1 + e^{-(\beta_0 + \beta_1 X)}]$$

or, in logit form:

$$\ln[P/(1-P)] = \beta_0 + \beta_1 X$$

where P is the probability of non-enrolment, β_0 is the intercept, β_1 is the regression coefficient, and X represents distance to the nearest public secondary school. The estimated coefficients were interpreted using odds ratios [OR = exp(β)], enabling the change in the odds of non-enrolment associated with a one-kilometre increase in school distance to be quantified. Statistical significance was evaluated at the 5% significance level ($p < 0.05$), while overall predictive performance was assessed using the model's classification accuracy.

The integration of survey, network analysis, and inferential statistical methods enabled the study to move beyond simple school-proximity assessment and evaluate actual, network-based student accessibility and its relationship with educational participation.

3.0 Results and Discussion

3.1 Students' Transport Mode to School

Figure 1 shows the travel modes of the 416 sampled students. Walking was the dominant mode (61%), followed by bicycle (16%), private automobile (13%), and public transport (10%), confirming the continued reliance on active travel for school access in Jos North LGA. The mean walking time was 31 minutes, corresponding to approximately 2–2.5 km at typical adolescent walking speeds of 4–5 km/h and therefore approaching or exceeding the 2 km recommended maximum walking distance to secondary schools (Sesugh et al., 2023; Agbabiaka, Aguda, & Nzere, 2020).

This finding is consistent with broader evidence from Sub-Saharan Africa and other low- and middle-income contexts, where walking remains the predominant school-travel mode (Srivastava, Sharma, & Sahay, 2025). The 61% walking share is comparable with the 53.7–57.5% reported among basic-school pupils in Accra, Ghana (Poku-Boansi et al., 2019), while the 31-minute mean walking duration is consistent with evidence from Accra (Tatah et al., 2022). More importantly, Bature and Barki (2019) reported that Nigerian secondary students walking more than 2 km frequently experienced fatigue and reduced classroom concentration, suggesting potential educational consequences of prolonged school journeys.

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The finding also complements Suleiman and Yusuf's (2026) geospatial assessment of Jos North, which found that although 84% of residential areas were within a 2 km school buffer, school locations followed an essentially random spatial pattern, leaving some wards underserved. The persistence of a 31-minute average walking time despite high buffer coverage indicates that conventional proximity measures may underestimate students' actual travel burden. Network discontinuities, indirect routes, and poor pedestrian connectivity can substantially increase real-world walking distances and travel times, particularly in peripheral and underserved wards.

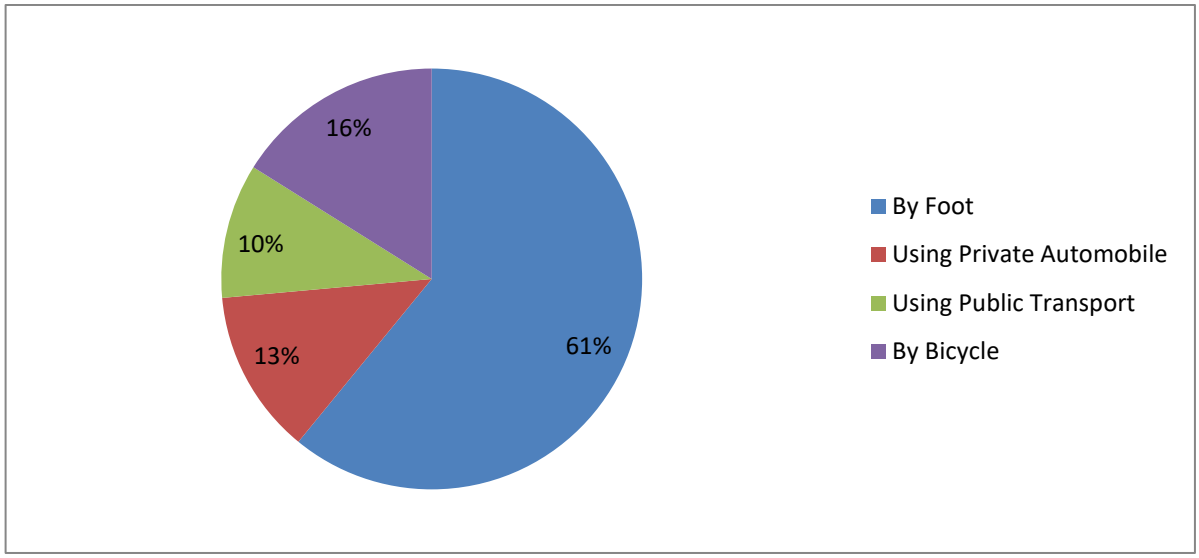

Figure 1: Students Transport Mode

3.2 Cost Implications of Student Commutes to School in Jos North

Figure 2 presents the daily monetary cost of students' school commutes. Most students (78%) spend less than ₦200 on transportation, while 18% spend ₦200–₦400 and 4% spend above ₦400. This strongly skewed distribution reflects the dominance of walking identified in Section 3.1, where 61% of students walk to school and therefore incur no direct transport fare. The low reported expenditure should consequently not be interpreted as evidence of generally affordable school transport, but rather as an outcome of widespread walking.

Current transport costs in Jos and comparable Nigerian cities indicate typical minibus and shared-taxi fares of ₦100–₦300 and motorcycle-taxi fares of ₦200–₦500 per trip (MOHAC Africa, 2026), broadly corresponding to the higher expenditure categories observed in this study. For low-income households, such costs can accumulate into a substantial school-related financial burden, particularly over a full school term. This is consistent with evidence that transportation constitutes an important component of household education expenditure in Nigeria (Jenkins, Anyabolu, & Bahramian, 2019), encouraging households to favour walking as a cost-minimisation strategy. Obiakor (2025) similarly identifies distance and transport cost as important considerations shaping household school-choice decisions.

Importantly, the apparent affordability indicated by Figure 2 masks a significant non-monetary burden. Combined with the 31-minute mean one-way walking time reported in Section 3.1, the findings suggest that many students effectively substitute time, physical effort, and fatigue for monetary transport costs. Thus, low commuting expenditure should be viewed as a potential

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indicator of transport disadvantage and distributive inequity rather than evidence of an efficient or affordable school-transport system.

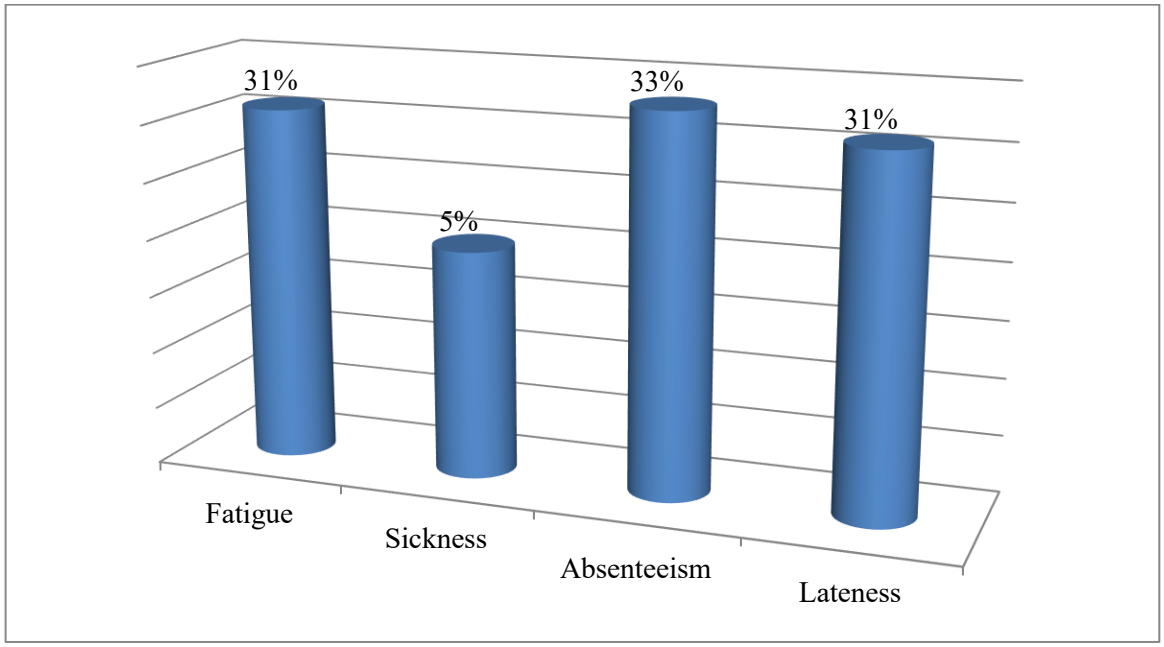

Figure 3: Challenges of Physical Accessibility on Students

3.3 Challenges of Physical Accessibility on Students in Jos North

Figure 3 presents the travel-related challenges experienced by students commuting to public secondary schools in Jos North LGA. Absenteeism was the most frequently reported impact (33%), followed by fatigue (31%) and lateness (31%), while sickness accounted for 5%. These findings are consistent with the travel patterns reported in Sections 3.1 and 3.2, where 61% of students walked an average of 31 minutes each way, while household transport constraints encouraged walking as a cost-minimisation strategy (Jenkins, Anyabolu, & Bahramian, 2019; Obiakor, 2025). The prevalence of fatigue is consistent with Mutonhodza (2025), who found that long, unassisted school journeys can cause physical exhaustion and reduced concentration, and with Bature and Barki (2019), who reported fatigue and drowsiness among Nigerian students walking more than 2 km to school.

The high incidence of lateness further supports evidence that journeys exceeding the 2 km accessibility threshold and poorly connected routes contribute to delayed school arrival (Agbabiaka, Aguda, & Nzere, 2020; Olayode et al., 2022). More critically, the prominence of absenteeism corroborates Zuilkowski et al. (2020), who associated longer school-travel distances with seasonal and chronic absenteeism in Northern Nigeria, and Obiakor (2025), who linked excessive commuting burdens to household decisions to withdraw from or substitute schools. The lower incidence of sickness nevertheless reflects evidence that students walking through unsheltered environments are more vulnerable to weather-related illness (Inusa et al., 2022). Overall, the findings demonstrate that inadequate physical accessibility imposes measurable costs on student wellbeing and educational participation, particularly through fatigue, lateness, and absenteeism. These burdens are likely to be greatest in the underserved and poorly connected wards identified by Suleiman and Yusuf (2026), highlighting the need to integrate school-location planning with pedestrian and transport infrastructure provision.

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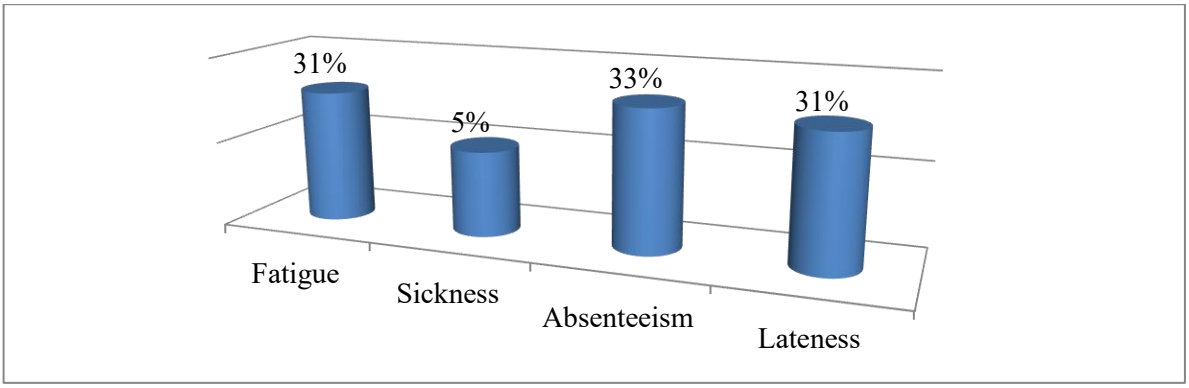

Figure 3: Challenges of Physical Accessibility on Students

3.4 Obstacles to Student Mobility in Accessing Schools in Jos North

Table 1 presents students' perceptions of barriers to school travel using a 5-point Likert scale. Unfavourable terrain and harsh weather recorded the highest mean scores (3.39 each), followed by conflict with motorists (3.33) and security incidents (3.18). All means exceeded the neutral midpoint (3.0), indicating that respondents generally perceived these factors as significant barriers to school access. The prominence of terrain-related constraints is consistent with Zhu, Zinda, Liu, Wang, Fu, and Li (2023), who demonstrated that topographic ruggedness significantly restricts school accessibility, while Sakamoto, Laudari, Fujioka, et al. (2024) documented elevated risks for children navigating flood-prone and topographically challenging routes in developing-country contexts. Similarly, Alade et al. (2023) found that poor walkway conditions increase physical exertion and pedestrian injury risks among Nigerian schoolchildren.

The relatively high rating for conflict with motorists further reflects the absence of adequate pedestrian infrastructure and the resulting unsafe pedestrian–vehicle interactions reported by Alade et al. (2023). The positive rating for security incidents is also consistent with UNICEF's (2024) evidence of persistent insecurity affecting students' safe journeys to and from schools in Nigeria. Considered alongside the travel-mode, cost, and commuting-challenge findings in Sections 3.1–3.3, these results demonstrate that environmental, infrastructural, and security constraints are structural components of the school journey rather than isolated inconveniences. Collectively, they compound students' travel time, physical fatigue, and financial burdens and reinforce the need for accessibility-oriented school siting, safer pedestrian infrastructure, and targeted transport interventions in underserved areas of Jos North LGA.

Table 1: Obstacles to Student Mobility in Accessing Schools in Jos North

S/N	Obstacle	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)	Mean
1	Unfavourable terrain	69	78	87	32	34	3.39
2	Clash and conflict with motorist	62	74	98	32	34	3.33
3	Security incidences	65	57	92	39	47	3.18
4	Harsh weather condition	66	74	100	32	28	3.39

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3.6 Average Travel Distance and Time of Residents to Schools in Jos North

Table 2 presents the average travel distance and time from residential areas to public secondary schools across Jos North wards, derived from the Origin–Destination (OD) matrix using Network Analyst and disaggregated by travel mode. Overall, the mean travel distance was 1.5 km, with corresponding travel times of 23, 6, 3, and 8 minutes by walking, bicycle, motorcycle, and car, respectively. Motorcycle was the most time-efficient mode, including relative to car travel, reflecting Jos North's undulating terrain and narrow, often unpaved routes that restrict four-wheeled vehicles but remain accessible to motorcycles. This finding is consistent with Suleiman and Yusuf's (2026) evidence of uneven road-network connectivity and Dodge and Nelson's (2023) argument that physical and infrastructural constraints shape realised travel-time accessibility beyond straight-line distance.

Although the overall 1.5 km average falls within the 2 km recommended maximum walking distance for secondary-school students (Sesugh et al., 2023; Agbabiaka, Aguda, & Nzere, 2020), substantial spatial disparities exist across wards. Naraguta B (2.6 km) and Tudun Wada–Kabong (2.3 km) exceeded the threshold, whereas Tafawa Balewa (0.5 km) and Ali Kazaure (0.6 km) recorded substantially shorter distances. This variation indicates that accessibility challenges are spatially uneven rather than uniformly distributed, reflecting disparities in school location and network connectivity. A similar pattern was reported by Oloko-Oba et al. (2016) in Ilorin West LGA, where 62% of students travelled less than 2 km to school while 32% travelled beyond the threshold. Collectively, the findings demonstrate that LGA-wide averages can conceal significant ward-level accessibility inequalities, underscoring the importance of spatially targeted school-siting and transport interventions.

Table 2: Average Travelling Length and journey Time to Schools by modes in the Study Area

S/N	Ward	Avg. Travelling Length (km)	Foot (min)	Bicycle (min)	Motorcycle (min)	Car (min)
1	Naraguta B	2.6	39	10	5	12
2	Abba Na Shehu	1.6	24	6	2	7
3	Sarkin Arab	1.0	15	3	1	1
4	Naraguta A	2.2	33	10	3	18
5	Janta Adamu	1.8	27	8	4	14
6	Janta Apata	1.0	16	4	2	5
7	Garba Daho	1.4	21	5	2	5
8	Gangare	1.2	18	5	2	5
9	Jos Jarawa	2.1	31	9	4	15
10	Tudun Wada-Kabong	2.3	34	9	4	14
11	Ibrahim Katsina	1.5	23	5	2	2
12	Vanderpuye	1.1	16	3	1	2
13	Ali Kazaure	0.6	10	3	2	5
14	Tafawa Balewa	0.5	8	2	1	1

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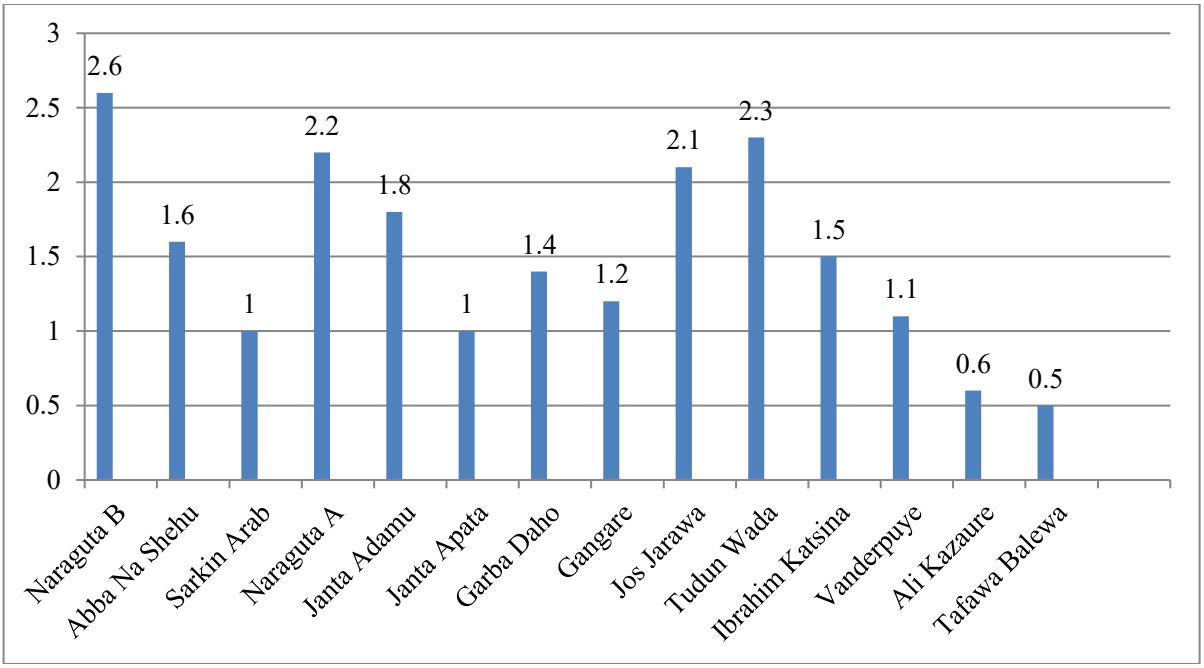
3.7 Average Travel Distance to Schools in the Administrative Wards of the Study Area

Figure 4 shows the average travelling distance to school across the individual wards of the study area. Children in Naraguta B travel the longest average distance to school (2.6 km), while those in Tafawa Balewa travel the shortest (0.5 km), producing a roughly fivefold gap in travelling distance across wards. This pronounced ward-level unevenness is consistent with recent Nigerian geospatial evidence: Lawal and Abdullahi (2025), examining Sokoto North and Sokoto South LGAs, similarly found that while overall school distribution patterns approximated randomness at the LGA level, peripheral wards nonetheless experienced markedly poorer proximity to schools than central, more urbanised wards, mirroring the centre–periphery disparity evident between Jos North's more distant wards (Naraguta B, Naraguta A, Tudun Wada-Kabong) and its more accessible ones (Tafawa Balewa, Ali Kazaure). This pattern is further corroborated at the national scale by GRID3 Nigeria's (2023) geospatial analysis of proximity to schools across Nigerian LGAs, which found substantial within- and between-LGA variation in the share of children living within the UBEC-mandated 2 km distance to the nearest school, underscoring that the ward-level disparities identified in Jos North reflect a broader, persistent pattern of spatially uneven school accessibility across Nigeria rather than a localised anomaly.



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3.8 Network Connectivity Analysis of the Road Network in the Study Area

The road network analysis comprised 1,063 nodes and 1,013 edges, indicating a relatively simple network structure with limited structural complexity. The Beta Index ($\beta = 0.953$) shows that the network contains approximately 0.95 links per node. This relatively low value suggests a predominantly simple network configuration with limited route redundancy and alternative paths. Consequently, the availability of alternative routes for accessing public secondary schools may be constrained, particularly where direct road or pedestrian connections are absent.

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The Gamma Index ($\gamma = 0.318$) indicates that approximately 31.8% of the maximum potential planar connections are realised within the network. This points to relatively limited network connectivity and route choice. From a school-accessibility perspective, such a configuration can increase the likelihood that students follow indirect routes to reach their schools, thereby increasing actual travel distance and journey time even where schools appear geographically close in straight-line distance. The implication is particularly important for students who walk or cycle, as they are more directly exposed to deficiencies in network continuity.

The calculated Alpha Index ($\alpha = -0.0231$) requires cautious interpretation. Although the value results mathematically from applying the conventional connected-network formula, $\alpha=(E-N+1)/(2N-5)\alpha=(E-N+1)/(2N-5)$, the network contains fewer edges than the 1,062 edges required to connect all 1,063 nodes. Therefore, the negative value should not be interpreted as negative connectivity. Rather, it indicates that the network is not a single fully connected component and that the standard Alpha formulation is inappropriate unless the number of disconnected components is incorporated. Thus, the reported Alpha value primarily signals network discontinuity and limited circuit development, rather than a meaningful negative level of connectivity.

Taken together, the β and γ indices indicate a relatively simple and incompletely connected road network characterised by limited route alternatives and network redundancy. These characteristics have important implications for equitable access to public secondary schools in Jos North LGA. Students residing in peripheral or underserved areas may experience longer network-based journeys than would be expected from proximity measures alone. Weak connectivity can therefore compound the effects of uneven school distribution by increasing walking distances, travel times, and exposure to adverse terrain, traffic conflicts and security risks. Improving road-network continuity, pedestrian pathways and strategic connecting links could consequently reduce actual travel burdens and enhance accessibility to public secondary schools.

3.8 Relationship between Distance to Public Schools and School Enrolment

Table 3 presents the relationship between distance to the nearest public secondary school and school enrolment using binary logistic regression. The model was statistically significant ($p<0.05p<0.05$) and correctly classified 76.3% of cases, resulting in rejection of the null hypothesis. The regression coefficient indicates that each 1 km increase in distance to the nearest public school increases the log-odds of non-enrolment by 0.119. Assuming 0.119 is the raw logit coefficient ($\beta\beta$), this corresponds to an odds ratio of approximately 1.126, indicating a 12.6% increase in the odds of non-enrolment for each additional kilometre of distance.

The finding supports the spatial mismatch hypothesis, which argues that inadequate spatial alignment between populations and essential services can generate exclusion where transport systems are constrained (Hu, Sherlock, Huang, Knopf, & Hall, 2024). Consistent evidence from South Africa shows that spatial mismatch between residential populations and schools is associated with reduced educational attainment (Machebele & Weir-Smith, 2025). Similarly, Bature and Barki (2019) found that greater school-travel distances significantly reduced attendance among students in Kanke LGA, Plateau State, owing to fatigue, insecurity, and transport costs, while Ajayi et al. (2021) reported that long journeys constrained female school enrolment in rural Ondo State through compounded safety and logistical challenges.

The results therefore demonstrate that distance is not merely a spatial measure but a potential barrier to educational participation. In Jos North, reducing the spatial separation between residential areas and public secondary schools, particularly in underserved wards, should form an important

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component of education and physical-planning policy. The reported Alpha Index value should, however, be verified against the original network-analysis output before inclusion, as its interpretation requires consistency with the theoretical bounds and calculation procedure of the index.

Table 3: Binary Logistics Regression Analysis of Distance and School Enrolment

		Coefficient (B)	Significance	Exp(B)
Step 1[a]	Distance to Nearest Public Secondary School in KM	-2.126	.0001	.119
	Constant	2.594	.0001	13.388

4.0 Conclusion and Recommendations

4.1 Conclusion

This study demonstrates that the distribution of public secondary schools in Jos North LGA has important implications for students' actual mobility and educational accessibility. Although 84% of residential areas fall within a 2-km proximity buffer of a public secondary school, network-based and student-reported evidence reveals substantial variation in actual travel burden. Walking is the dominant mode (61%), with an average walking time of 31 minutes, while students in peripheral and underserved wards experience considerably longer journeys. Travel-related challenges, particularly absenteeism, fatigue and lateness, further indicate that distance and network conditions can translate spatial disadvantage into educational disadvantage. The logistic regression confirms a significant relationship between distance to school and enrolment, while the road-network analysis indicates relatively limited connectivity and route alternatives. Overall, the findings show that school accessibility cannot be adequately assessed through proximity-based measures alone; actual network distance, travel time, transport mode, safety and affordability must also be considered.

5.2 Recommendations

1. Prioritise underserved areas for new schools: Planning authorities should prioritise additional public secondary schools in identified underserved wards, particularly Gangare and Tudun Wada–Kabong, where longer travel distances and accessibility constraints are evident.

2. Adopt network-based accessibility standards: Future school-location planning should move beyond simple Euclidean or buffer-based accessibility and incorporate road-network distance, travel time, pedestrian connectivity and terrain when determining school catchments and service areas.

3. Improve pedestrian connectivity: Investment should focus on continuous pedestrian pathways, safe crossings and strategic road links connecting residential areas with schools, particularly along routes heavily used by walking students.

4. Integrate transport and education planning: School siting decisions should be coordinated with road and public transport planning to ensure that educational facilities are accessible to students from peripheral communities.

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5. Strengthen student safety: Traffic-calming measures, pedestrian crossings, street lighting and safer school-access corridors should be provided along major student walking routes to reduce conflicts with motorists and security risks.

6. Institutionalise accessibility monitoring: Education and planning authorities should periodically use GIS-based accessibility assessments and student travel surveys to identify emerging underserved areas and guide future school investment.

Collectively, these measures would help reduce excessive student travel burdens, improve equitable access to public secondary education and support more spatially responsive urban planning in Jos North LGA.

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