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Spatial Inequality in Urban Road Infrastructure Provision: Evidence from Nasarawa State, Nigeria

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Abstract **Original Research Article**

Urban road infrastructure is fundamental to spatial integration, mobility, and socio-economic development. However, in many developing regions, the provision of urban roads infrastructure is spatially uneven, thereby reinforcing disparities in accessibility and development opportunities. This study assesses the nature of spatial inequality in urban road infrastructure provision across selected urban areas of Nasarawa State, Nigeria, namely Lafia, Keffi, Akwanga, and Nasarawa towns. The study adopts a mixed-methods approach integrating Geographic Information Systems (GIS), spatial network analysis, household surveys, field observations, and institutional assessments. Quantitative techniques such as connectivity indices, road density analysis, detour indices, and regression analysis were employed alongside qualitative thematic analysis. Findings reveal substantial disparities in urban roads infrastructure distribution and quality across the sampled urban areas. Lafia and Keffi exhibit relatively higher levels of connectivity and road network efficiency, while Akwanga and Nasarawa towns are characterised by fragmented and poorly integrated networks. The study further identifies institutional fragmentation, weak planning coordination, poor maintenance culture, and political influence as key drivers of spatial inequality in infrastructure provision. The absence of a gazetted urban hierarchy and integrated urban development framework significantly undermines equitable urban road infrastructure distribution within the state. The study concludes that spatial inequality in road infrastructure provision constrains accessibility, mobility, and balanced urban development in Nasarawa State. It recommends the formulation of an integrated urban roads development framework, strengthening institutional coordination, adoption of GIS-based planning systems, and prioritisation of equitable infrastructure investment strategies.

Keywords: Spatial inequality, urban roads, infrastructure provision.

1. Introduction

Urban road infrastructure plays a significant role in promoting accessibility, economic productivity, and spatial integration within urban systems. Roads facilitate the movement of people, goods, and services while supporting social and economic interactions across urban regions (Glaeser, 2011). In rapidly urbanising regions, efficient road infrastructure contributes to balanced urban growth, accessibility to opportunities, and regional competitiveness

(Banister, 2008). However, in many developing countries, urban road infrastructure provision remains uneven and inadequate, thereby reinforcing socio-spatial inequalities and constraining sustainable urban development.

In Nigeria, the provision of road infrastructure has historically reflected colonial economic priorities that focused on extractive connectivity rather than integrated regional development (Ishamali & Adie, 2024). Consequently, many urban areas continue to experience weak interconnectivity, poor accessibility, and fragmented transportation networks. Nasarawa State presents a significant example of these challenges. Despite its strategic proximity to the Federal Capital Territory (FCT), Abuja, road infrastructure provision within the state remains spatially uneven, with administrative centres such as Lafia and Keffi receiving relatively greater investment than peripheral urban areas (Adama, 2020).

Spatial inequality in urban road infrastructure manifests in poor connectivity, longer travel times, weak network integration, and uneven accessibility to socio-economic opportunities. Areas such as Toto, Keana, and Doma despite being among the urban areas in the State experience severe infrastructural deficits, limiting mobility and constraining regional integration. These disparities are compounded by institutional fragmentation, inadequate planning frameworks, poor maintenance culture, and politically motivated infrastructure allocation (Igbozurike, 2018). The resulting inequalities undermine balanced urban development and perpetuate socio-economic exclusion.

Globally, scholars have emphasised the importance of equitable infrastructure provision in fostering inclusive urban systems (Geurs & van Wee, 2004; Litman, 2021). Accessibility-oriented planning approaches advocate for integrated transport systems that prioritise equitable access to services, employment, and economic opportunities. In many developed countries, integrated transport planning frameworks and GIS-based infrastructure management systems have significantly improved urban mobility and spatial equity (Pojani & Stead, 2015). In contrast, many developing regions continue to struggle with fragmented governance structures and inadequate infrastructure financing mechanisms.

This study therefore examines spatial inequality in urban road infrastructure provision across selected urban areas in Nasarawa State, Nigeria. Specifically, it evaluates road network distribution, connectivity patterns, and accessibility disparities using GIS and spatial network analysis. The study further investigates institutional and governance factors influencing infrastructure provision and proposes strategic measures for promoting equitable urban road development.

Literature Review

2.1 Urban Road Infrastructure and Spatial Inequality

Urban road infrastructure constitutes a critical component of urban systems, influencing mobility, accessibility, and socio-economic development. Efficient road networks facilitate spatial interaction, reduce transportation costs, and enhance economic productivity (Banister, 2008). Conversely, inadequate road infrastructure contributes to congestion, poor accessibility, and spatial exclusion, particularly for vulnerable populations (Litman, 2002).

Spatial inequality in infrastructure provision refers to the uneven distribution of infrastructure resources across geographic areas and social groups. According to Geurs and van Wee (2004), accessibility disparities emerge when certain urban areas enjoy better transport connectivity and mobility opportunities than others. In developing countries, road infrastructure investments are often concentrated in economically and politically significant urban centres, leaving peripheral communities underserved (Mabogunje, 2007).

In Nigeria, urban road infrastructure provision has largely favoured major urban centres while secondary towns and peri-urban areas experience infrastructural neglect (Ipingbemi, 2010). This imbalance appeared to have contributed to weak inter-urban integration, poor mobility, and socio-

economic disparities. The concentration of road investments in core urban areas suggested to have reinforced uneven development patterns and limits regional accessibility.

2.2 Spatial Network Analysis and Accessibility

Spatial network analysis provides a framework for evaluating road connectivity, accessibility, and network efficiency. Connectivity indices such as Alpha, Beta, and Gamma indices are commonly used to assess network integration and redundancy (Bertolini et al., 2005). Road density and detour indices further provide insights into the adequacy and efficiency of road systems.

Accessibility refers to the ability of individuals to reach desired services and opportunities through available transport systems (Geurs & van Wee, 2004). High accessibility reflects efficient mobility systems and integrated road networks, while poor accessibility indicates infrastructural deficiencies and mobility constraints. In developing regions, accessibility challenges are often associated with poor inter-urban connectivity, poor road quality, weak maintenance systems, and limited transport alternatives (Litman, 2021).

2.3 Institutional Framework and Urban Road Provision

Institutional effectiveness significantly influences infrastructure planning and provision. Strong governance systems facilitate coordinated planning, transparent resource allocation, and effective project implementation (Healey, 2006). However, many developing countries experience fragmented governance structures, inadequate funding, and political interference in infrastructure delivery (Igbozurike, 2018).

In Nasarawa State, road infrastructure provision seems to have largely dominated by state institutions with limited inter-agency coordination and weak local government participation. The absence of an integrated urban development framework and gazetted urban hierarchy further appeared to constrains strategic infrastructure planning. Public-private partnerships (PPPs), though recognised as viable financing mechanisms, remain weakly institutionalised within the state (Hodge & Greve, 2007).

2. Methodology

The study adopted a mixed-methods research design integrating quantitative and qualitative approaches. The study focused on four major urban centres in Nasarawa State: Lafia, Keffi, Akwanga, and Nasarawa towns.

The four urban areas as shown in figure 3.1 demonstrate a networked structure shaped by transport infrastructure, environmental context, and socio-economic functions. Their differing topographies from Lafia's low-lying plains to Akwanga's uplands and Nasarawa's riverine environment create diverse but complementary economic bases, while shared tropical savanna climatic conditions support agricultural productivity across the system. The interurban road network serves as the backbone of this system, enabling mobility, trade, and administrative coordination, though challenges such as weak inter-urban connectivity and seasonal access disruptions in the urban areas highlight systemic vulnerabilities. Thus, these urban areas operate not as isolated entities but as interdependent components of a dynamic regional urban system, where infrastructure provision directly influences spatial integration and development outcomes.

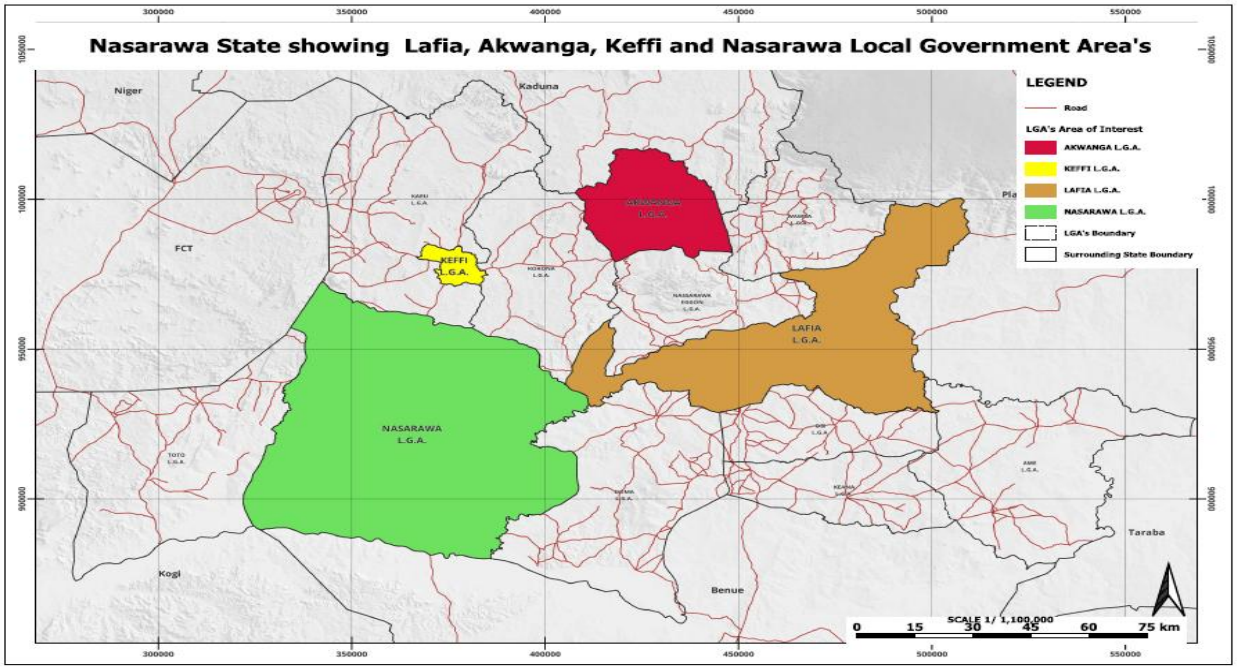

Figure 3.1: Map of Nasarawa State showing the Study Areas.

Source: Nasarawa State Urban Development Board (2026).

The study employed both primary and secondary sources of data. Primary data were obtained through household surveys, field observations, GPS mapping, and key informant interviews. Secondary data included planning documents, GIS datasets, road maps, policy documents, and institutional reports from relevant agencies. A total of 1,534 respondents were sampled across the study areas using stratified random sampling and purposive sampling techniques (Table3.1).

Table 3.1: Sampling Frame and Distribution of Respondents by Stakeholder Group

Stakeholder Group	Sampling Technique	Sample Size
Government Officials	Purposive Sampling	50
Community Members/Road Users	Stratified Random Sampling	1,200
Private Sector Stakeholders	Purposive Sampling	34
Academic and Institutional Experts	Purposive Sampling	25
Total	-	**1,534**

Source: Field Survey, 2026.

GIS and spatial network analysis techniques were employed to assess road density, connectivity, centrality, and accessibility patterns. Connectivity indices such as Alpha (α), Beta (β), and Gamma (γ) indices were used to evaluate network efficiency. Regression analysis

was further employed to examine factors influencing accessibility and infrastructure performance. Qualitative data were analysed using thematic analysis and SPSS coding techniques (Table 3.2).

Table 3.2: Summary of Variables, Data Sources and Analytical Techniques

Variables	Data Source	Analytical Technique
Road density, connectivity, centrality	GIS, GPS, field mapping	GIS network analysis
Travel time, accessibility index	Household survey, GIS	Accessibility modelling
Governance effectiveness, coordination	Interviews, policy documents	Content and thematic analysis
Investment sustainability, PPP adoption	Institutional records	Policy evaluation

Source: Author's Compilation, 2026.

3. Results and Discussion

4.1 Spatial Distribution of Urban Road Infrastructure

Figures 4.1-4.4 are maps of the study areas generated from GIS showing the nature of spatial urban roads network. The analysis revealed substantial disparities in the urban road infrastructure distribution across the sampled urban areas. Lafia exhibited the highest road density of 1.75 km/km², followed by Keffi with 1.45 km/km², while Akwanga recorded the lowest density at 1.20 km/km². The concentration of paved roads and higher-order road networks in Lafia and Keffi reflects preferential infrastructure investment within politically and administratively significant urban areas.

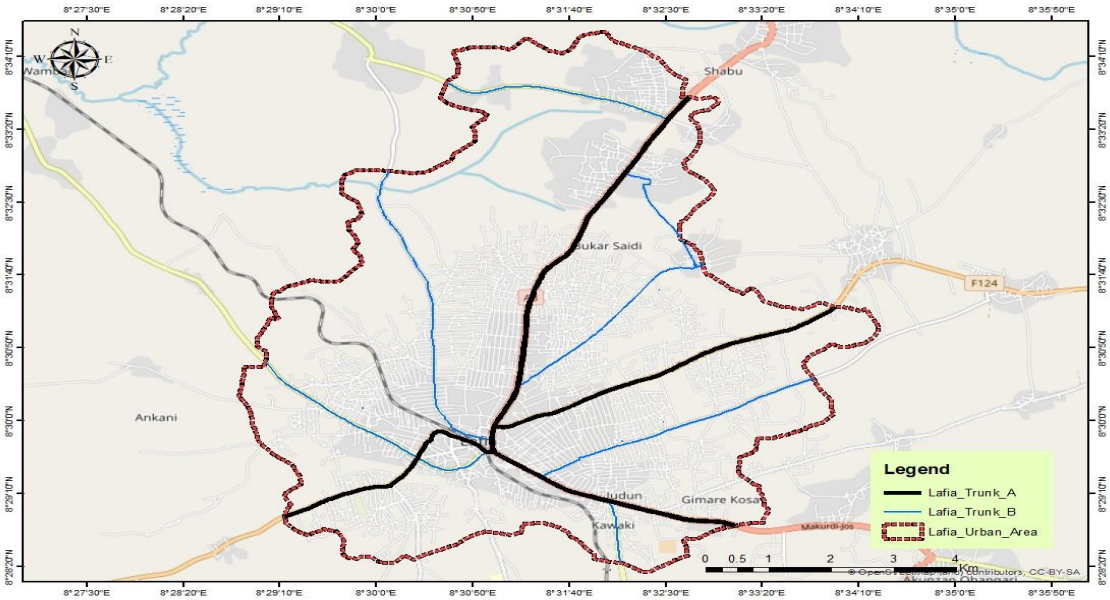

Figure 4. 1: Map Lafia Urban Area showing the Road Networks.

Source: Nasarawa State Government (2024)

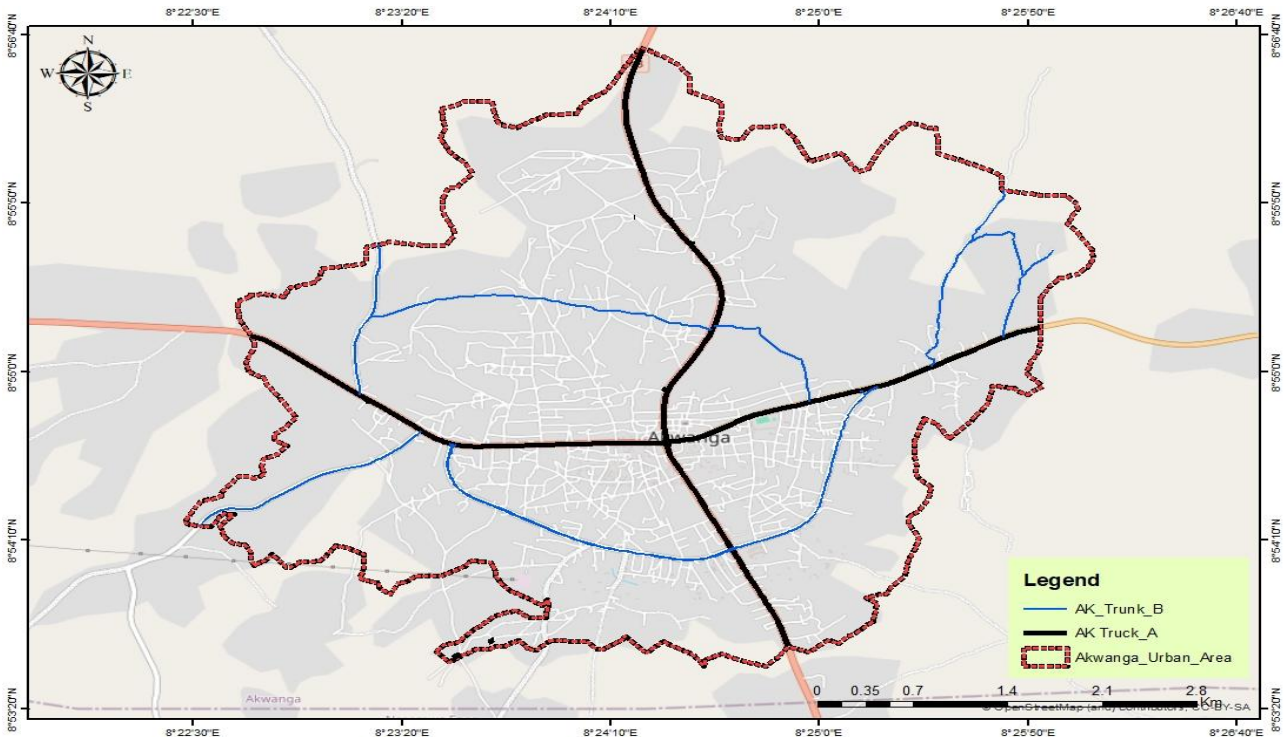

Figure 4.2: Map Akwanga Urban Area showing the Road Networks.

Source: Nasarawa State Government (2024)

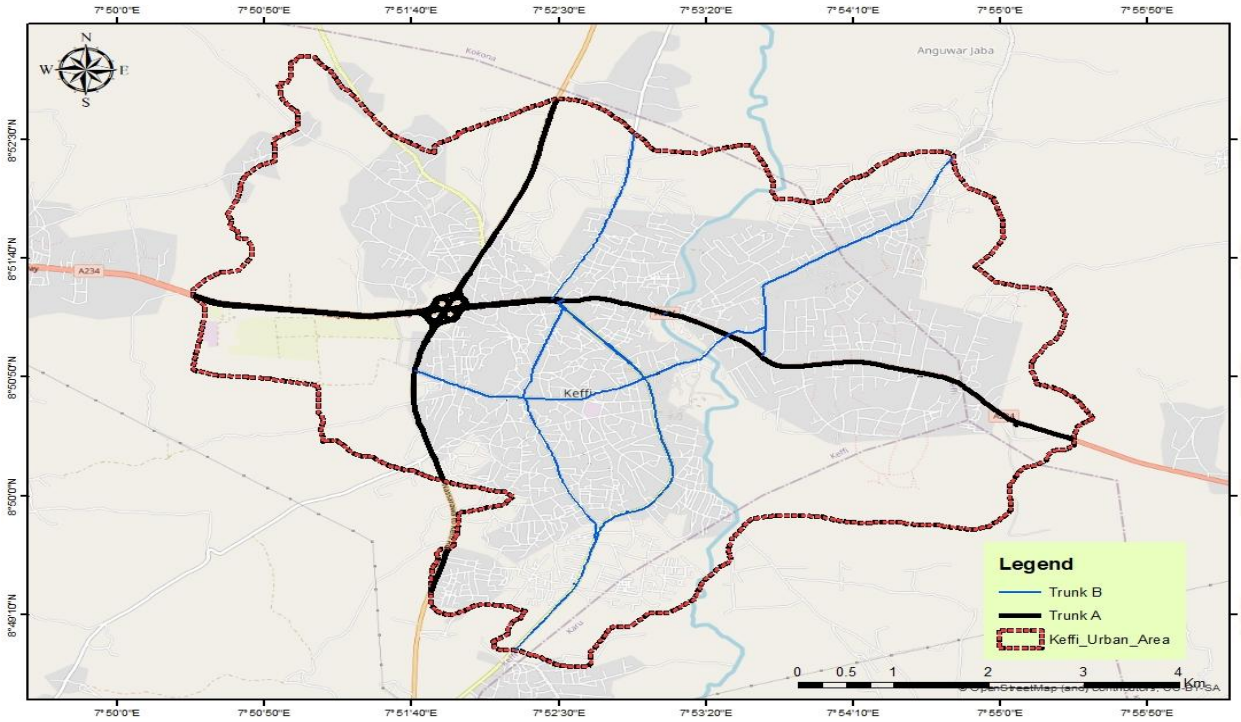

Figure 4.3: Map Keffi Urban Area showing the Road Networks.

Source: Nasarawa State Government (2026)

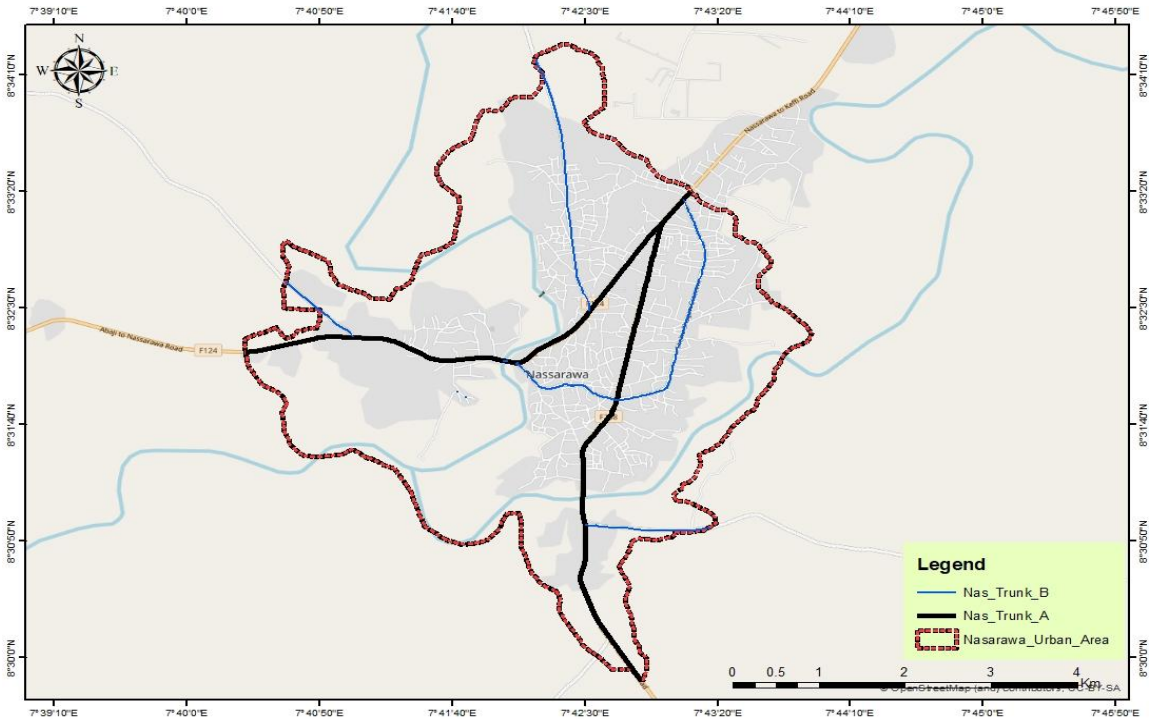

Figure 4.4: Map Nasarawa Urban Area showing the Road Networks.

Source: Nasarawa State Government (2026)

The spatial analysis as shown in tables 4.2 and 4.3 further revealed that local roads dominate the network structure across all urban centres, accounting for approximately 50-77% of total road length. Expressways and arterial roads accounted for less than 15% across the towns, indicating weak hierarchical road development. Lafia exhibited the most balanced road structure among the sampled urban areas.

Table 4.2: Classes of Urban Road Networks(km)

Classes	Lafia Length (km)	Lafia %	Akwanga Length (km)	Akwanga %	Keffi Length (km)	Keffi %	Nasarawa Length (km)	Nasarawa %
Express ways	12.6	9	2.3	4	4.9	7	3.0	3
Arterial Roads	14.1	10	3.4	6	4.9	7	4.0	4
Collector Roads	36.5	26	9.7	17	14.1	20	8.1	8
Local Roads	77.2	55	41.7	73	46.5	66	85.8	85
Total	**140.48**	**100**	**57.06**	**100**	**70.41**	**100**	**100.9**	**100**

Source: Field survey, 2026.

Table 4.3: Road Density Across the Sampled Urban Centres

Urban Centre	Road Density (km/km²)	Rank
Lafia	1.75	1st
Keffi	1.45	2nd
Nasarawa	1.35	3rd
Akwanga	1.20	4th

Source: GIS Output, 2026.

Road condition assessment (Table 4.4) showed that Lafia recorded the highest proportion of paved roads (64%), while Nasarawa town had only 26% paved roads. Akwanga and Nasarawa towns also exhibited significant deficiencies in drainage systems, road width, and street lighting.

Figure 4.5 shown the state of road network conditions of interurban roads of the sampled urban areas. These disparities indicate uneven infrastructural development and weak maintenance systems across the state.

Table 4.4: Condition of Roads in the Sampled Urban Centres

Urban Centre	Paved Roads (%)	Unpaved Roads (%)
Lafia	64	36
Keffi	52	48
Akwanga	29	71
Nasarawa	26	74

Source: Field Survey, 2026.

Urban road condition

(Lafia urban area)

Urban road condition and accident scene along Keffi-Nasarawa Road

Unpaved road condition

(Nasarawa urban area)

Absence of drainage

(Keffi urban area)

Absence of drainage and Accident scene (Akwanga urban area)

Figure 4.5: Typical Condition of Interurban Roads

Source: Field survey, 2024

4.2 Connectivity and Accessibility Patterns

Connectivity analysis results shown in table 4.5 further demonstrated variations in network efficiency across the study areas. Lafia recorded the highest connectivity indices with Beta (β = 1.32), Gamma (γ = 0.64), and Alpha (α = 0.45), indicating relatively efficient network integration. In contrast, Akwanga and Nasarawa towns exhibited fragmented road systems with lower connectivity levels and poor redundancy.

Table 4.5: GIS Connectivity Analysis (Indices Across the Sampled Urban Areas)

Urban Centre	Beta Index (β)	Gamma Index (γ)	Alpha Index (α)
Lafia	1.32	0.64	0.45
Keffi	1.18	0.57	0.36
Nasarawa	1.05	0.49	0.28
Akwanga	0.97	0.42	0.21

Source: GIS Network Analysis, 2026.

Observed travel times results between urban areas in table 4.6 significantly exceeded ideal travel times across major corridors. The Lafia-Nasarawa corridor recorded the highest Travel Time Index (TTI = 1.73), suggesting poor interurban connectivity and accessibility, poor road conditions, and weak network integration within the sampled urban areas and also to other urban areas of the Nasarawa state.

However, Tables 4.6- 4.8 shows the dynamism of inter-urban connectivity and accessibility within the sampled urban areas. These also shown that the accessibility challenges were particularly appeared to be severe in peripheral urban areas where, poor road infrastructure limited socio-economic interactions and service accessibility.

Table 4.6: Observed Inter-Urban Travel Time across Selected Corridors

Corridor	Observed Travel Time	Accessibility Condition
Lafia – Nasarawa	4:00 hrs	Poor
Lafia – Keffi	1:50 hrs	Moderate
Akwanga – Keffi	1:00 hr	Fair
Keffi - Karu/Mararaba	1:00 hr	Moderate

Source: Field Survey, 2026.

Table4.7: Number of inter-urban roads linked between sampled and the catchment urban areas

Sampled urban areas. (Origin)	Linked urban areas. (Destination)	Inter-urban linked	Est. Distance in km	Est. time in Hours
Lafia	Nass-Egon	1Main Lafia-Nass-Egon rd. Via A343	22	0:45
	Doma	1Main Lafia-Doma rd. A3 corridor	22	0:30
	Obi	1Main Lafia-Obi rd.	36	1:00
	Keana	1Main Lafia-Keana rd.	90	1:40
Akwanga	Garaku	1Main A3/A343 Akwanga-Garaku rd.	37	0:45
	Wamba	1Main Akwanga- Wamba rd.	26	1:00
	Nass-Egon	1Main Akwanga-Nass-Egon rd.	36	0:45
Keffi	Garaku	1Main: A3 Keffi-Garaku rd.	30	0:50
	Karu	1Main Abuja-Keffi express way A234	45	1:20
	Nasarawa	1Main Keffi-Nass. Part of Keffi- Toto corridor.	43	1:20
Nasarawa	Keff	1Main Keffi-Nass. Part of Keffi- Toto corridor.	43	1:20
	Toto	1Main Keffi-Nass-Toto rd.	70	1:30

Source: *Field survey, 2026.*

Table 4.8: Calculation of inter-urban connectivity indices

Index	Formular	Calculation	Result	Interpretation
Beta(β)	$\beta=\frac{e}{r}=\frac{edges}{nodes}$	12/12	1.00	1 edge per node on average. β> 1= Circuit. B<1= $\frac{tree}{dendritic}$
Gama(γ)	$r=\frac{e}{emax}$ *where emax*= 3(v- for planar network	***e**max*= 3(12-12/30)	0.40 or 40%	40% of all possible plannar connected. 1.0= full connected. >0.5 is fairly connected
Alha(α)	$A=\frac{e-y-p}{2v-5}$ for p=1 subgraph	$\frac{12-12+1}{2(12)-5=1}$= *1/19*	0.053 or 5.3%	% of circuits present Vs possible. Low= few alternative routes, high vulnerability.

Source: *SPSS analysis, 2026.*

These findings align with previous studies that identify inadequate urban road infrastructure as a major barrier to mobility and regional integration in Nigerian urban systems (Ipingbemi, 2010; Adama, 2020). Spatial inequality in road provision therefore contributes directly to uneven development outcomes and socio-economic exclusion.

3.4 Institutional and Governance Factors

Institutional analysis shown in Table 4.9 and Figure 4.6 revealed significant governance weaknesses affecting urban road infrastructure provision in Nasarawa State. Approximately 45% of respondents rated institutional effectiveness as weak, while only 22% acknowledged the effective adoption of public-private partnerships.

Table 4.9: Comparative Governance Scorecard for Road Infrastructure Provision

Domain	Indicator	Benchmark Target	Nasarawa State	Gap vs Target	Status
Policy Framework	Road policy updated ≤ 5 years	Yes	No	–1 (lagging)	●
Budget Execution	% of approved budget spent on roads	≥ 85%	72%	–13%	□
Procurement	Avg. procurement cycle (days)	≤ 60	95	+35 days	●
Institutional Capacity	Engineers per 100 km road	≥ 4	2.3	–1.7	□
Coordination	Quarterly joint reviews held	4 per year	2	–2	□
Community Engagement	% of grievance cases resolved	≥ 80%	54%	–26%	●
Transparency	Audit queries resolved (%)	≥ 90%	65%	–25%	●

Composite Governance Index = 62/100.

Legend: □ = Meets/exceeds benchmark; □ = Moderate gap; ● = Critical gap.

Key Insights:

1. **Quantitative:** Governance indices strongly predict road quality (R^2 = .48). Budget execution and institutional capacity are the most influential predictors.
2. **Qualitative:** Stakeholders consistently point to weak enforcement, delays in budget release, poor coordination, and tokenistic engagement as barriers.
3. **Comparative:** Nasarawa underperforms in policy updates, procurement timeliness, transparency, and engagement compared to benchmarks.

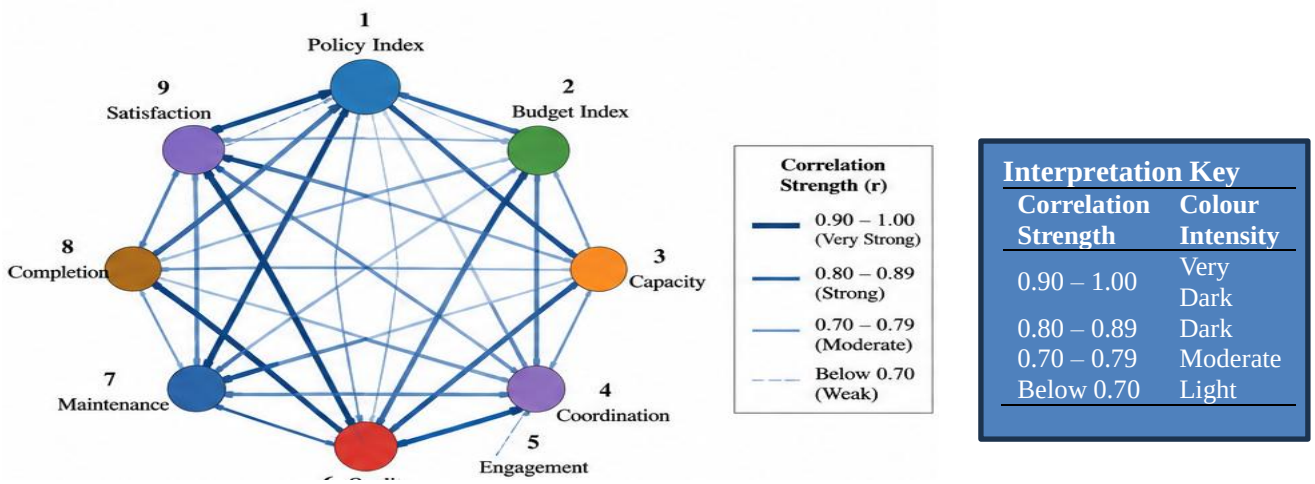

Figure 4.6: Network Diagram of relationship between Governance Indicators and Urban Road Infrastructure Outcome.

Source: SPSS Output, 2024

Additionally, stakeholders identified poor funding, corruption, political interference, and weak coordination among agencies as major barriers to infrastructure development as shown in Table 4.10.

Table 4.10: Stakeholder Perceptions of Institutional Challenges

Institutional Issue	Observation
Funding	Delayed releases and underfunding
Coordination	Overlapping institutional responsibilities
Political Influence	Politically motivated project allocation
Community Participation	Limited stakeholder engagement
Maintenance	Weak maintenance culture

Source: Field Interviews and SPSS Analysis, 2026.

Thematic analysis further revealed as shown in Tables 4.11- 4.12, that infrastructure investment decisions were often politically motivated, with flagship projects concentrated in high-profile urban centres. Community participation in infrastructure planning remained limited, thereby weakening inclusive development processes. Furthermore, the absence of a gazetted urban hierarchy undermined strategic infrastructure prioritisation across urban areas.

Table 4.11: Thematic Matrix (Themes × Stakeholder Groups)

Theme	Policymakers (NUDA, MOW, GKDCA)	Contractors	Planners/Experts	Residents
Policy Frameworks	Policies exist but outdated; poor enforcement	Complain of shifting standards	See lack of alignment with national urban development policy	Little awareness
Budget Allocations	Delays in release, underfunding	Complain about payment arrears	Note inadequate cost control	See funds mismanaged
Institutional Capacity	Shortage of skilled engineers	Delays from lack of machinery	No clear urban development policy and urban areas gazettement	Complain of poor supervision
Coordination	Overlaps between NUDA, MOW & GKDCA	Confusion over responsibilities	Data not shared	Residents blame "too many agencies"
Community Engagement	Meetings rare, mostly tokenistic	Rarely consulted	Weak grievance redress	"We are not carried along"
Outcomes	Pride in flagship roads	Complain of project abandonment	Highlight poor maintenance culture	"Roads spoil too fast"

Source: SPSS Analysis, 2026.

Table 4.12: Thematic Matrix of Stakeholder Responses

Theme	Major Observation
Policy Framework	Weak and poorly enforced
Budget Allocation	Delays and inadequate releases
Institutional Capacity	Shortage of skilled personnel
Coordination	Fragmentation among agencies
Community Engagement	Minimal public participation
Project Outcomes	Poor maintenance and abandoned projects

Source: SPSS Thematic Coding, 2026.

These findings support Healey's (2006) argument that fragmented governance structures hinder effective urban planning and infrastructure delivery. The lack of integrated planning frameworks and institutional coordination therefore contributes significantly to spatial inequality in infrastructure provision within Nasarawa State.

4. Conclusion

This study examined spatial inequality in urban road infrastructure provision across selected urban areas in Nasarawa State, Nigeria. The findings reveal significant disparities in road network distribution, connectivity, and accessibility. Lafia and Keffi benefit from relatively higher infrastructure investment and network efficiency, while Akwanga and Nasarawa towns remain underserved and poorly connected.

The study further established that institutional fragmentation, poor planning coordination, weak maintenance culture, and political influence contribute significantly to unequal infrastructure provision. The absence of a comprehensive urban development framework and formal urban hierarchy further exacerbates infrastructural disparities and undermines balanced regional development. Spatial inequality in urban road infrastructure not only constrains mobility and accessibility but also reinforces socio-economic exclusion and uneven urban growth. Addressing these challenges requires integrated planning approaches, equitable infrastructure investment strategies, and strengthened institutional coordination.

5. Recommendations, Limitations, and Areas for Further Research

The findings of this study indicate the need for the Nasarawa State Government to formulate and implement an Integrated Urban Roads Development Framework to guide the equitable provision, upgrading, expansion, and maintenance of road infrastructure across the state. Such a framework should reflect the functional roles, population characteristics, economic importance, and development needs of individual urban centres. Establishing a formal urban hierarchy would support the strategic prioritisation of infrastructure investments and promote more balanced regional development. This approach is consistent with the principles of integrated spatial planning, which emphasise the coordination of land use, transportation, infrastructure investment, and regional development objectives (UN-Habitat, 2020; World Bank, 2022).

The institutionalisation of Geographic Information System (GIS)-based planning and monitoring is also recommended to improve infrastructure mapping, spatial analysis, needs assessment, project prioritisation, and evidence-based decision-making. GIS can assist planning authorities in identifying underserved areas, monitoring road conditions, evaluating accessibility, and tracking changes in infrastructure provision over time (Goodchild, 2007; Longley et al., 2015). Institutional coordination among state agencies, local governments, and urban development authorities should also be strengthened to reduce duplication of responsibilities, improve planning coherence, and enhance the implementation and monitoring of road projects. In addition, sustainable financing mechanisms, including public-private partnerships, road trust funds, infrastructure bonds, and other innovative funding arrangements, should be promoted to support the construction, rehabilitation, upgrading, and routine maintenance of urban roads. Effective infrastructure financing and maintenance are essential for ensuring the long-term functionality and sustainability of transport networks (World Bank, 2017).

Participatory planning should be institutionalised to ensure that residents, community organisations, professional bodies, and other relevant stakeholders are involved in identifying, prioritising, implementing, and monitoring urban road projects. Community participation can improve transparency, accountability, inclusiveness, and the responsiveness of infrastructure interventions to local needs. It can also strengthen public

ownership and contribute to the sustainability of completed projects. However, participation should be supported by clear institutional procedures, accessible information, and effective mechanisms for incorporating community views into formal planning and budgeting processes.

This study has several limitations that should be acknowledged. First, the analysis was restricted to selected urban centres in Nasarawa State, which may limit the generalisability of the findings to all urban areas in the state or to other regions of Nigeria. Second, limitations in the availability, accuracy, and currency of spatial, demographic, financial, and infrastructure data may have affected the precision of the analysis. Third, the study primarily examined the spatial distribution and accessibility of road infrastructure and may not have fully captured other important dimensions, including road quality, traffic volume, travel time, safety, user satisfaction, and the socio-economic effects of poor connectivity. In addition, institutional and political influences were assessed largely through available evidence and stakeholder perspectives, which may have been affected by reporting bias or incomplete disclosure.

Future research should expand the geographical scope of analysis to include all urban centres in Nasarawa State and, where possible, comparable urban areas in other Nigerian states. Longitudinal studies would be useful for examining changes in road infrastructure provision, accessibility, and spatial inequality over time. Further research should integrate road quality assessments, traffic and travel-time data, road safety indicators, public transport accessibility, and household-level socio-economic information. The application of advanced spatial techniques, including network analysis, spatial econometric modelling, remote sensing, and high-resolution GIS datasets, could provide deeper insights into the relationship between road infrastructure and urban development. Future studies should also examine the effectiveness of alternative financing models, institutional reforms, and participatory planning approaches in improving the equitable and sustainable provision of urban road infrastructure.

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