

Understanding the Drivers of Land Use Conversion and their Traffic Implications in Gwagwalada Town, Nigeria

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Abstract: Rapid land-use conversion in rapidly urbanising areas often occurs without adequate consideration of its implications for transportation, creating growing traffic pressures and complicating urban management. This study examined the drivers of land-use conversion and their implications for traffic congestion in Gwagwalada Town, Nigeria. A cross-sectional survey design was adopted, involving 384 households selected from a study population of 140,635 residents using proportional and systematic sampling techniques. Data were collected through structured questionnaires and traffic observations at eight selected junctions. Questionnaire data were analysed using descriptive statistics, Pearson correlation and multiple linear regression, while traffic conditions were assessed through observed traffic volumes and peak-hour traffic pressure. Social factors recorded the highest perceived influence on land-use conversion (mean = 4.17), followed by policy/political (3.61), economic (3.47) and physical factors (3.11). All four determinant groups were significantly correlated with perceived traffic congestion: social ($r = .71, p < .001$), economic ($r = .64, p < .001$), policy/political ($r = .59, p < .001$) and physical ($r = .42, p < .001$). The regression model was significant ($R^2 = .68$; adjusted $R^2 = .67$; $F(4,379) = 201.40, p < .001$), with social factors showing the strongest standardized effect ($\beta = .41$), followed by economic ($\beta = .30$), policy/political ($\beta = .22$) and physical factors ($\beta = .15$). Traffic observations further showed substantial volumes along major corridors, with Glada Main Market recording the highest peak-hour pressure ($V/C = .97$). The study concludes that land-use conversion in Gwagwalada is closely associated with traffic pressure through interacting social, economic, policy and physical factors. The study contributes empirical evidence for integrating land-use management with transportation planning in emerging urban areas. It recommends stronger land-use monitoring, traffic-sensitive development approval, corridor access management and six-monthly land-use and traffic reviews.

Keywords: Land-Use Conversion; Traffic Congestion; Urban Development; Land-Use Planning; Traffic Management.

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I. INTRODUCTION

Land use conversion, involving the transformation of agricultural, undeveloped or other land into residential, commercial, institutional and industrial uses, is a major process through which urban areas expand and restructure. Global urban expansion has increasingly occurred through the conversion of previously undeveloped land, particularly in rapidly urbanising regions of Asia and Africa (Seto et al., 2012). Built-up land has also expanded faster than population in many developing regions, contributing to lower densities, greater spatial separation of activities and longer travel distances (Angel et al., 2011). Land conversion, however, is rarely attributable to a single factor. It reflects interactions among demographic, economic, institutional, technological

and biophysical processes operating across different spatial scales (Lambin et al., 2001; Verburg et al., 2004).

The process is particularly pronounced in peri-urban areas, where agricultural and undeveloped land is progressively incorporated into expanding urban settlements. In sub-Saharan Africa, continuing urbanisation is expected to intensify the pressure for land conversion as populations, investment and urban functions increasingly extend beyond established city boundaries (Sakketa, 2023). Peri-urban areas often experience weak development control, fragmented land markets and inadequate coordination between spatial planning and infrastructure provision. Consequently, land development can occur ahead of formal planning and public infrastructure (Ayeni et al., 2025). Strategic spatial planning

can influence these processes, but its effectiveness depends substantially on implementation, institutional coordination and development control (Hersperger et al., 2018).

The relationship between land use and transportation is similarly well established. Density, diversity, design, destination accessibility and distance to transport facilities influence travel demand and mobility patterns (Cervero & Kockelman, 1997; Ewing & Cervero, 2010). The relationship is reciprocal because development generates travel while accessibility can influence where development occurs (Handy, 2005). Where urban expansion occurs without corresponding transport infrastructure, increased travel demand can produce operational pressure on road networks. Cervero (2013) notes that this challenge is particularly important in developing countries where rapid urbanisation, motorisation and weak integration between land-use and transport planning frequently occur simultaneously.

Evidence from African cities illustrates this relationship. In Lagos, substantial expansion of built-up land has occurred alongside changes in transport infrastructure and travel demand, with weak integration of land-use and transport systems identified as an important planning challenge (Otuoze et al., 2021). Similarly, research in other African cities has shown that poorly coordinated urban growth can increase traffic pressure while reducing the environmental and spatial qualities of urban areas (Dyachia et al., 2017). However, the strength and direction of the relationship between land-use change and congestion vary across locations and depend on the analytical methods and indicators employed (Kanyepe et al., 2021).

The Abuja city-region provides an important context for examining these processes. Since Abuja became Nigeria's Federal Capital, rapid urban expansion has extended beyond the Federal Capital City into surrounding satellite settlements. Between 1987 and 2017, built-up land in the Abuja city-region increased substantially while vegetation cover declined, with urban expansion occurring in areas previously designated for other uses (Enoguanbhor et al., 2019). Earlier research also documented outward expansion towards satellite settlements surrounding Abuja (Mahmoud et

al., 2016). However, implementation of development plans has remained problematic, with insufficient resources, limited manpower, and weak development control and institutional challenges affecting spatial planning within the city-region (Enoguanbhor et al., 2021).

Gwagwalada Town is one of the important satellite settlements within this expanding urban system. Population growth, institutional development, housing investment, land-market activity and employment opportunities have contributed to increasing demand for land. These processes have been accompanied by changes in the spatial distribution of residential, commercial and institutional activities and increasing traffic pressure at major activity nodes. Yet existing studies of the Abuja region have largely concentrated on land-cover change, urban expansion and planning challenges, with comparatively limited empirical attention to the relationship between the drivers of land conversion and observed traffic conditions within individual satellite towns.

This study therefore examines the drivers of land use conversion and their traffic implications in Gwagwalada Town. Specifically, it assesses the principal social, economic, policy/political and physical determinants of land use conversion, examines their association with perceived traffic congestion, and analyses observed traffic conditions at selected junctions. The study provides empirical evidence for understanding how rapid peri-urban transformation interacts with transportation pressures in a growing Nigerian satellite town.

II. MATERIAL AND METHODS

➤ *Study Area and Research Design*

Gwagwalada Town, located within the Gwagwalada Area Council of the Federal Capital Territory (FCT), Abuja, was selected for this study due to its rapid urbanization, dynamic land use patterns, and emerging traffic challenges. The town is a rapidly developing peri-urban satellite of Abuja, comprising three of the council's ten political wards, Gwagwalada Central, Kutunku, and Staff Quarters. Together, these wards accounted for approximately 38.07% of the council's 2006 population of 157,770.

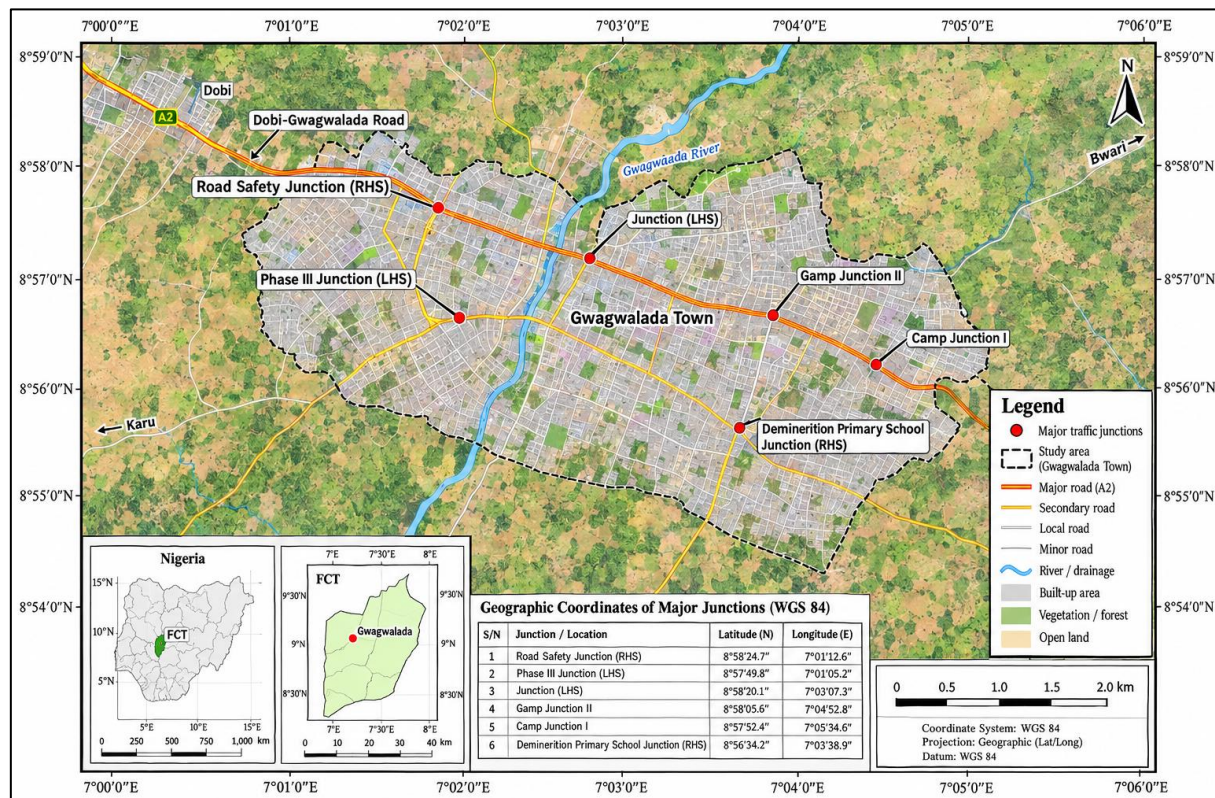


Fig 1 Study Area Map: Gwagwalada Town, FCT, Nigeria

➤ Sample Size and Sampling Procedure

The study population comprised 140,635 residents distributed across Gwagwalada Central, Kutunku, and Staff Quarters wards. The sample size was determined using Cochran's formula at a 95% confidence level, a 5% margin of error, and maximum variability ($p = 0.50$).

The initial sample size was calculated as:

$$n_0 = Z^2 pq / e^2$$

Where:

- n_0 = initial sample size for an infinite population
- Z = standard normal deviate at a 95% confidence level (1.96)
- p = estimated population proportion (0.50)
- $q = 1 - p = 0.50$
- e = margin of error (0.05)

Substituting the values:

$$n_0 = [(1.96)^2(0.50)(0.50)] / (0.05)^2$$

$$n_0 = (3.8416 \times 0.25) / 0.0025$$

$$n_0 = 0.9604 / 0.0025 = 384.16$$

Thus, the initial sample size was approximately:

$$n_0 \approx 384$$

Since the study population was finite, the finite population correction was applied:

$$n = n_0 / [1 + ((n_0 - 1) / N)]$$

Where

$N = 140,635$. Therefore:

$$n = 384.16 / [1 + ((384.16 - 1) / 140,635)]$$

$$n = 384.16 / (1 + 0.002725)$$

$$n = 384.16 / 1.002725 = 383.12$$

The minimum required sample was therefore approximately 383 respondents. This was rounded up to 384 respondents for the study.

To allow for an anticipated 10% non-response rate, the number of questionnaires administered was calculated as:

$$n_a = n / (1 - r)$$

Where n_a is the number of questionnaires to be administered and r is the anticipated non-response rate.

$$n_a = 384 / (1 - 0.10)$$

$$n_a = 384 / 0.90 = 426.67$$

Thus, 427 questionnaires were administered.

Proportional allocation was subsequently used to distribute the target of 384 valid responses across the three wards. The allocation formula was:

$$n_i = n(N_i / N)$$

Where n_i is the sample allocated to ward i , n is the total sample size (384), N_i is the population of ward i , and N is the total study population (140,635).

Table 1 Proportional Allocation of Questionnaires by Ward

Ward	Population (N_i)	Proportion (N_i/N)	Allocated sample (n_i)
Gwagwalada Central	67,505	0.4799	184
Kutunku	45,003	0.3199	123
Staff Quarters	28,127	0.2000	77
Total	140,635	1.0000	384

Source: Authors' Survey, 2025

For example, the allocation for Gwagwalada Central was calculated as:

$$n_i = 384(67,505 / 140,635)$$

$$n_i = 384(0.4799) = 184.32 \approx 184$$

Similarly, the allocations for Kutunku and Staff Quarters were:

$$n_i = 384(45,003 / 140,635) = 122.88 \approx 123 \text{ and}$$

$$n_i = 384(28,127 / 140,635) = 76.80 \approx 77 \text{ respectively.}$$

Within each ward, households were selected systematically from available household listings. The sampling interval was determined by dividing the number of listed households by the allocated sample:

$$k = N_h / n_i$$

Where k is the sampling interval, N_h is the number of listed households, and n_i is the allocated sample for the ward. For example, where 13,501 households were listed in a ward with an allocated sample of 184:

$$k = 13,501 / 184$$

$$k = 73.38 \approx 73$$

A random starting number between 1 and 73 was selected, after which every 73rd household was approached for questionnaire administration. Of the 427 questionnaires administered, 398 were returned, representing a response rate of:

$$\text{Response rate} = (398 / 427) \times 100 = 93.2\%$$

After screening for completeness and consistency, 384 questionnaires were retained for analysis. This represents:

$$(384 / 427) \times 100 = 89.9\% \text{ of the questionnaires administered.}$$

➤ Measurement and Reliability

The questionnaire measured respondents' perceptions of four broad determinants of land-use conversion: social, economic, policy/political, and physical factors. A separate

set of items measured perceived traffic congestion. Responses were obtained using a five-point Likert scale ranging from 1, representing strongly disagree, to 5, representing strongly agree.

Internal consistency was assessed using Cronbach's alpha. The coefficients were 0.84 for the social construct, 0.81 for the economic construct, 0.79 for the policy/political construct, and 0.86 for the congestion construct. These coefficients indicate satisfactory to high internal consistency among the items used to measure each construct.

Because the determinant and congestion measures were obtained through the same questionnaire, the possibility of common-method variance was also considered. Harman's single-factor test was conducted using an unrotated factor solution. The first factor accounted for 31.4% of the total variance, which was below the commonly applied 50% screening threshold for substantial common-method bias. This result indicates that a single factor did not account for most of the observed variance, although it does not rule out all possible forms of common-method bias.

➤ Traffic Data Collection and Conversion

Traffic counts were conducted at nine selected junctions representing major access, commercial, institutional, residential, and mixed-use locations within Gwagwalada Town. Counts covered a 16-hour period, from 06:00 to 22:00, on Monday, Wednesday, and Saturday.

Vehicles were recorded by direction and classified according to vehicle type. Observed traffic flows were converted to passenger car units (PCU) using adopted equivalency factors for the relevant vehicle classes.

Peak-hour traffic demand was calculated as the sum of PCU-adjusted vehicle flows recorded during the highest one-hour period. Junction capacity was estimated using the adopted saturation-flow and observed discharge-flow procedure. The volume-to-capacity ratio was calculated as:

$$V/C = \text{Peak-hour traffic demand (PCU/h)} / \text{Junction capacity (PCU/h)}$$

Where V represents peak-hour traffic demand in PCU/h and C represents estimated junction capacity in PCU/h. A V/C ratio above 0.85 was adopted as the threshold for

identifying peak-hour congestion. For example, where Gwagwalada Main Market Junction recorded a peak-hour demand of 3,880 PCU/h against an estimated capacity of 4,000 PCU/h:

$$V/C = 3,880 / 4,000$$

$$V/C = 0.97$$

The resulting ratio of 0.97 exceeded the adopted threshold of 0.85 and was therefore classified as indicating peak-hour congestion.

➤ Statistical Analysis

Data from the 384 valid questionnaires were analysed using descriptive and inferential statistics. Grand means were calculated for the four determinant categories and interpreted as follows: 4.00–5.00 indicated strong influence; 3.40–3.99 indicated moderate influence; 3.00–3.39 indicated weak-to-moderate influence; and values below 3.00 were rejected.

Pearson's correlation coefficient was used to assess the association between the four determinant categories and perceived traffic congestion. Effect sizes were interpreted using Cohen's conventional benchmarks. Multiple linear regression analysis was subsequently conducted to estimate the unique contribution of the four determinants to perceived traffic congestion.

Before regression analysis, the assumptions of normality, homoscedasticity, and multicollinearity were examined using the Shapiro–Wilk test, Breusch–Pagan test, and variance inflation factors, respectively. The residuals satisfied the normality and homoscedasticity assumptions ($p > 0.05$), while variance inflation factor values below 2.5 indicated no serious multicollinearity.

The regression coefficients reported as B represent unstandardised coefficients, while standardised beta coefficients (β) were used to compare the relative contribution of the predictors. Statistical significance was evaluated at $p < 0.05$.

III. RESULTS AND DISCUSSION

➤ Drivers of Land Use Conversion and Perceived Traffic Congestion

The results show that respondents perceived social factors as the strongest drivers of land use conversion in Gwagwalada. Social determinants recorded a grand mean of 4.17, indicating strong influence, while policy/political determinants recorded 3.61 and economic determinants 3.47, both indicating moderate influence. Physical determinants recorded the lowest mean of 3.11, indicating weak-to-moderate influence.

Table 2 Drivers of Land Use Conversion and their Relationship with Perceived Traffic Congestion

Determinant category	Grand mean	Interpretation	Pearson's r	p-value	Standardised β
Social	4.17	Strong influence	0.71	<0.001	0.41
Policy/political	3.61	Moderate influence	0.59	<0.001	0.22
Economic	3.47	Moderate influence	0.64	<0.001	0.30
Physical	3.11	Weak–moderate influence	0.42	<0.001	0.15

Source: Authors' Survey, 2025.

The prominence of social determinants suggests that population growth, immigration, institutional concentration, cultural activities and other forms of social activity are important pressures underlying land conversion in Gwagwalada. This finding corresponds with the broader land-use change literature, which identifies demographic pressure as one component of land transformation while emphasising that it interacts with economic, institutional and technological forces (Lambin et al., 2001). Urban expansion therefore reflects more than an increase in population; it also involves the emergence and spatial concentration of activities that require land. The result is particularly relevant to Gwagwalada because schools, religious institutions, markets and other activity centres can simultaneously attract population, stimulate surrounding development and generate additional travel. The land-use and transport literature similarly establishes that density, diversity and the spatial arrangement of activities influence travel demand (Cervero & Kockelman, 1997; Ewing & Cervero, 2010).

Economic determinants recorded a mean of 3.47 and were significantly associated with perceived congestion ($r = 0.64$, $p < 0.001$). Their standardised regression coefficient of $\beta = 0.30$ indicates a substantial independent contribution.

Land investment, housing demand, employment opportunities, land values and commercial activity can increase the attractiveness of particular locations for development and intensify travel demand. This finding is consistent with land-use change theory, which views urban transformation as an interaction of economic opportunities, demographic pressures and institutional conditions (Lambin et al., 2001; Verburg et al., 2004).

Policy/political determinants also recorded a significant association with perceived congestion ($r = 0.59$, $p < 0.001$), with $\beta = 0.22$ in the regression model. This result is important because planning decisions determine where development is permitted, the intensity at which it occurs and the extent to which infrastructure accompanies development. Evidence from the Abuja city-region has identified weak implementation of spatial plans, limited development-control capacity, inadequate funding and institutional coordination as important challenges to effective land-use planning (Enoguanbhor et al., 2021). The Gwagwalada findings are therefore consistent with the wider Abuja experience.

Physical determinants recorded the lowest mean (3.11) and the weakest correlation with perceived congestion ($r =$

0.42, $p < 0.001$), although the relationship remained statistically significant. This suggests that respondents considered physical factors less influential than social, economic and institutional processes. The result should not, however, be interpreted as evidence that physical conditions are unimportant to development suitability. Rather, it indicates that respondents did not perceive them as the principal drivers of conversion. At the individual-item level, tax incentives recorded a mean of 2.20 and hydrology 2.00. Both therefore fell below the study's acceptance threshold. The low score for tax incentives indicates that respondents did not identify formal fiscal incentives as a major factor influencing conversion. Similarly, the low hydrology score reflects respondents' perceptions and does not establish that environmental conditions have no implications for land development.

Generally therefore, the results demonstrate that land conversion in Gwagwalada is better understood as a multi-dimensional process. The findings correspond with Lambin et al. (2001), who caution against monocausal explanations of land-use change, and with Hersperger et al. (2018), who emphasise the role of strategic spatial planning and its implementation in shaping urban land-use outcomes.

➤ Regression Model of Perceived Traffic Congestion

The combined regression model was statistically significant and explained 68% of the variance in perceived traffic congestion ($R^2 = 0.68$; adjusted $R^2 = 0.67$; $F(4,379) = 201.4$, $p < 0.001$).

Table 3 Multiple Linear Regression of Perceived Traffic Congestion on Land-Use Determinants

Predictor	B	SE	t	p-value	Standardised β
Constant	1.25	0.21	5.95	<0.001	—
Social determinants	0.42	0.08	5.25	<0.001	0.41
Economic determinants	0.35	0.09	3.89	<0.001	0.30
Policy/political determinants	0.28	0.07	4.00	<0.001	0.22
Physical determinants	0.19	0.08	2.38	0.018	0.15

Model Statistics: $R^2 = 0.68$; Adjusted $R^2 = 0.67$; $F(4,379) = 201.4$; $P < 0.001$.

Source: Authors' Survey, 2025.

The regression results in Table 3 reinforce the correlation analysis. Social determinants had the largest unique contribution to perceived congestion ($\beta = 0.41$), followed by economic determinants ($\beta = 0.30$), policy/political determinants ($\beta = 0.22$) and physical determinants ($\beta = 0.15$). The findings indicate that the factors associated with land conversion are also systematically related to respondents' perceptions of congestion. This is consistent with the land-use–transport interaction literature, which considers urban development and mobility as mutually reinforcing processes (Handy, 2005). Development increases the number and distribution of trips, while accessibility and transportation conditions influence the location and intensity of subsequent development.

However, the regression should not be interpreted as establishing causation. The cross-sectional design does not establish temporal precedence, and the explanatory and outcome variables were collected from the same respondents. The R^2 therefore represents the proportion of variance in

perceived congestion statistically explained by the four predictors within this sample rather than proof that the determinants independently cause congestion. The Harman single-factor result provides some evidence against a dominant common-method factor, but it cannot completely eliminate this concern. The relatively high explanatory power should consequently be interpreted alongside the study design and measurement limitations.

➤ Observed Traffic Volume at Major Junctions

The questionnaire findings indicate substantial associations between land-use determinants and perceived congestion. The traffic observations provide complementary evidence concerning the actual intensity and spatial distribution of movement within the town. Traffic observations were available for eight of the nine surveyed junctions for comparative analysis. Demonstration Primary School was excluded because comparable Wednesday and Saturday observations were unavailable.

Table 4 Observed Two-Way Traffic Volume by Junction, 06:00–22:00

Junction	Monday	Wednesday	Saturday	Saturday vs Monday (%)
I. Dobi–Gwagwalada Road	42,334	41,599	39,379	–7.0
II. Road Safety	38,574	39,648	32,294	–16.3
III. Phase III	27,780	28,231	23,380	–15.8
IV. Glada Main Market	43,710	44,476	45,013	+3.0
V. Area Council	28,087	29,283	20,395	–27.4
VI. Town-Hall	36,518	39,163	29,286	–19.8
VII. Jaj Camp I	32,070	32,958	25,257	–21.2
VIII. Jaj Camp II	30,854	31,666	27,237	–11.7

Source: Authors' Traffic Survey, 2025.

The observed traffic volumes show considerable spatial and temporal variation. Gwagwalada Main Market recorded the highest traffic volume on Monday, Wednesday and Saturday, with 43,710, 44,476 and 45,013 observed movements respectively. It was also the only junction where Saturday traffic exceeded Monday traffic, increasing by 3.0%. This pattern is consistent with the role of commercial activity in generating and attracting travel. Cervero and Kockelman (1997) demonstrate that diversity and intensity of urban activities influence travel demand, while Ewing and Cervero (2010) similarly identify built-environment characteristics as important correlates of travel behaviour. The Saturday increase at Glada Main Market further suggests that the temporal profile of traffic varies according to land-use function. Traffic declined at the other seven junctions on Saturday. The largest reductions occurred at Area Council (–27.4%), Jaj Camp I (–21.2%) and Town-Hall (–19.8%). These differences indicate that traffic demand is not spatially uniform and that the function of individual locations

influences when and how intensively they generate or attract trips.

The results should nevertheless be distinguished from congestion. Traffic volume measures the intensity of movement, but a high volume does not necessarily indicate congestion where sufficient capacity exists. For this reason, observed volume provides descriptive evidence, while the V/C analysis provides an indication of operational pressure. This distinction is consistent with the wider transport literature, which treats congestion as a relationship between travel demand and available network capacity rather than simply as a measure of vehicle numbers. It also reinforces the need for land-use and transport planning to be considered together, particularly in rapidly expanding settlements.

➤ *Peak-Hour Traffic Pressure*

Peak-hour V/C ratios were calculated for the eight junctions with complete traffic observations. The results are presented in Table 5.

Table 5 Peak-Hour Volume-to-Capacity Ratios at Surveyed Junctions

Junction	Adjacent land-use character	Peak-hour V/C	Interpretation
IV. Glada Main Market	Commercial	0.97	Above threshold
I. Dobi–Gwagwalada Road	Mixed	0.91	Above threshold
II. Road Safety	Mixed	0.88	Above threshold
VI. Town-Hall	Institutional	0.86	Above threshold
VII. Jaj Camp I	Residential	0.74	Below threshold
VIII. Jaj Camp II	Residential	0.71	Below threshold
V. Area Council	Institutional	0.67	Below threshold
III. Phase III	Residential	0.65	Below threshold

Source: Authors' Traffic Survey, 2025.

- *Note: A V/C ratio above 0.85 was adopted as the study threshold for identifying high peak-hour operational pressure.*

Four of the eight analysed junctions exceeded the 0.85 threshold. Glada Main Market recorded the highest V/C ratio of 0.97, followed by Dobi–Gwagwalada Road at 0.91, Road Safety at 0.88 and Town-Hall at 0.86. The remaining four junctions recorded ratios between 0.65 and 0.74. The concentration of higher V/C ratios around commercial, mixed-use and institutional locations corresponds with the survey evidence that social and economic determinants are strongly associated with perceived congestion. It is also consistent with the established relationship between activity concentration and travel demand (Cervero & Kockelman, 1997; Ewing & Cervero, 2010).

The pattern should, however, be interpreted as an observed spatial relationship, rather than evidence that land-use category independently causes congestion. Junction geometry, traffic control, parking activity, pedestrian movements, and public transport operations and turning movements may also influence capacity and operational performance. The present study did not statistically test these factors. The high V/C ratio at Glada Main Market is particularly significant when considered alongside its observed traffic volumes. The market had the highest traffic

count on each observation day and was also the only junction to record increased Saturday traffic. This convergence of high observed volume and high peak-hour V/C indicates substantial operational pressure around the commercial node.

The findings support the argument for integrated land-use and transport planning. Banister (2008) emphasises that sustainable mobility requires attention to urban form and accessibility rather than relying exclusively on conventional capacity expansion. Similarly, Hersperger et al. (2018) demonstrate that strategic spatial planning can influence urban land-use outcomes where planning is effectively implemented. In the Abuja city-region, Enoguanbhor et al. (2021) identified inadequate plan implementation, limited resources and weak development-control capacity as major planning challenges. The Gwagwalada evidence indicates why these institutional issues matter for transportation: development at activity-generating locations can increase travel demand and operational pressure where supporting infrastructure is inadequate.

➤ *Integrated Interpretation of Land Use Conversion and Traffic Implications*

Taken together, the results indicate that land-use conversion and traffic pressure in Gwagwalada are interconnected through social, economic and institutional processes. Social determinants recorded the highest perceived influence on land conversion and the strongest

association with perceived congestion. Economic and policy/political determinants also demonstrated substantial statistical relationships, while physical determinants had a comparatively smaller contribution. The traffic observations provide an important complementary perspective. Higher operational pressure was concentrated at selected commercial, mixed-use and institutional nodes, while residential junctions generally recorded lower V/C ratios. This suggests that the traffic implications of land conversion depend not simply on the amount of land converted but also on the type of use introduced, its intensity, its location and the travel demand it generates or attracts.

This interpretation is consistent with Lambin et al. (2001), who conceptualise land-use change as the outcome of interacting proximate and underlying drivers. It also corresponds with Cervero and Kockelman (1997) and Ewing and Cervero (2010), whose work demonstrates that the spatial configuration and diversity of urban activities influence travel behaviour.

The Gwagwalada findings further illustrate the reciprocal nature of the land-use–transport relationship identified by Handy (2005). New development can create additional travel demand, but locations with better accessibility can simultaneously become more attractive for further development. Consequently, congestion may emerge not simply because urban growth is occurring but because the spatial pattern and intensity of growth are not adequately coordinated with transportation infrastructure.

The findings are particularly relevant to peri-urban settlements, where urban expansion frequently occurs faster than the provision of supporting infrastructure. Seto et al. (2012) and Angel et al. (2011) demonstrate the global scale of urban expansion, while evidence from Abuja indicates that expansion has involved substantial conversion of previously non-urban land and has occurred alongside planning and development-control challenges (Enoguanbhor et al., 2019; Enoguanbhor et al., 2021). Thus, the evidence from Gwagwalada supports an integrated rather than sectoral planning approach. Land-use decisions concerning major commercial, institutional and mixed-use developments should be considered alongside their likely implications for movement and junction capacity.

IV. CONCLUSION

This study examined the drivers of land use conversion and their traffic implications in Gwagwalada Town, Nigeria. The findings demonstrate that land-use conversion is influenced by interacting social, economic, policy/political and physical factors, with social determinants recording the highest perceived influence (mean = 4.17). All four determinant categories were significantly associated with perceived traffic congestion. Social determinants recorded the strongest association ($r = 0.71$, $p < 0.001$), followed by economic determinants ($r = 0.64$), policy/political determinants ($r = 0.59$) and physical determinants ($r = 0.42$). The regression model explained 68% of the variance in perceived congestion, with social determinants making the

largest unique contribution ($\beta = 0.41$), followed by economic ($\beta = 0.30$), policy/political ($\beta = 0.22$) and physical determinants ($\beta = 0.15$).

The traffic observations complement these findings by demonstrating that movement pressure is spatially concentrated. Glada Main Market recorded the highest observed traffic volume across the three observation days and was the only junction where Saturday traffic exceeded Monday traffic. Four of the eight junctions with complete observations recorded V/C ratios above the adopted 0.85 threshold, with Glada Main Market recording the highest ratio of 0.97. The findings indicate that the traffic implications of land conversion depend on the type, intensity and location of development and the extent to which transport infrastructure accompanies urban growth. The concentration of higher operational pressure around commercial, mixed-use and institutional locations is consistent with established land-use–transport literature, although the present study does not establish a causal effect of particular land-use categories on congestion.

The study therefore highlights the importance of integrating land-use planning and transport planning in Gwagwalada. Development-control decisions, particularly for major commercial, institutional and mixed-use developments, should be considered alongside accessibility, trip-generation potential and available transport capacity. Strengthening coordination between planning and transport institutions and incorporating both weekday and weekend traffic patterns into development assessment would provide a more responsive planning framework for the town. Future research should integrate GIS-based measurements of actual land-use conversion, longitudinal traffic counts, household travel behaviour and junction-level capacity analysis. Such an approach would provide stronger evidence on the temporal and spatial pathways through which peri-urban land conversion influences travel demand and traffic congestion.

RECOMMENDATIONS

- Strengthen land-use monitoring. The FCT Department of Development Control and Gwagwalada Area Council should monitor land-use changes quarterly and update the town's land-use records annually. This will help detect unauthorised conversions early and ensure that new developments conform to approved plans.
- Control development along congested corridors. The FCT Administration and Gwagwalada Area Council should regulate roadside parking, trading and uncontrolled access along Glada Main Market, Dobi–Gwagwalada Road and Road Safety corridors. Designated parking, loading areas and access points should be provided, with six-monthly traffic counts used to assess improvement.
- Make traffic assessment part of development approval. The Department of Development Control should require a simple Traffic Impact Assessment for major commercial, institutional and mixed-use developments. Developers should provide adequate parking, access and circulation facilities before approval is granted.

- Reduce unauthorised land-use conversion. The planning and development-control authorities should maintain a register of approved land-use changes and inspect development sites at least quarterly. Unapproved conversions should receive enforcement action in accordance with planning regulations.
- Establish joint land-use and traffic reviews. The FCT Administration, Gwagwalada Area Council and relevant transport agencies should review land-use and traffic conditions every six months using development records, updated land-use information and traffic counts. The findings should guide decisions on development control, junction improvement and traffic management.

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