# Land-Use Configuration and Traffic Flow Dynamics: Implication for Sustainable Transport Planning in Ilorin Metropolis

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## ABSTRACT

Rapid urbanization in developing cities exacerbates transportation challenges, underscoring the critical interplay between land-use configuration and traffic flow dynamics. This study aimed at analyzing the dynamics between land-use configuration and traffic flow in Ilorin Metropolis, Nigeria, a medium-sized city experiencing acute congestion due to unplanned spatial growth, with the aim of generating evidence-based strategies for sustainable transport planning. A mixed-methods approach was utilized, combining data collection through traffic surveys at six major intersections during peak and off-peak periods, spatial analysis of satellite imagery, and 344 administered questionnaires across three Local Government Areas. Analytical techniques included descriptive statistics, Principal Component Analysis (PCA) to determine the factors shaping land-use patterns, while Multiple Linear Regression modeled the relationship between varying land-use types and traffic flow. Key findings reveal a dominant residential land-use (37.6%), with significant unplanned conversion to commercial uses along arterial corridors, yet commercial and market zones exert disproportionate impacts on traffic dynamics. PCA identified economic activities as the paramount driver of land-use patterns (81.54% variance), followed by population density (11.91%). R = 0.507, confirmed commercial areas and markets as the primary significant predictors of traffic congestion, accounting for 50.7% of traffic flow variability. Critical intersections like Muritala/Amilegbe handle over 4,000 vehicles per hour during peaks, with congestion exacerbated by inadequate infrastructure, poor signalization, and roadside trading. The study concludes that Ilorin's traffic inefficiencies are fundamentally rooted in a misalignment between land-use concentration and transport capacity. It. recommends integrated land-use and transport policies, modernization of intersections, decentralization of commercial hubs, and investment in sustainable public transport to foster balanced urban mobility.

**Keywords:** Land-Use Configuration, Traffic Flow, Sustainable Transport, Ilorin Metropolis

## INTRODUCTION

Rapid urbanization remains a dominant phenomenon globally, posing significant challenges for transportation systems in developing cities. The spatial configuration of land-use strongly influences traffic flow, travel demand, and the efficiency of mobility systems (Newman & Kenworthy, 2016; Camagni et al., 2022). The interplay between land-use and traffic circulation determines accessibility, congestion, and urban sustainability. Poorly coordinated land-use systems often produce inefficient traffic movement, extended commuting times, and increased environmental pressures (Schmidt & Müller, 2019). Land-use configuration dictates trip generation, distribution, and mode choice, while transportation infrastructure reciprocally shapes urban form and development (Litman & Steele, 2020).

Globally, sustainable transport planning emphasizes integrating land-use and transportation to reduce congestion and enhance accessibility (Cervero & Kockelman, 2019). International experiences in Europe and Asia show that compact, mixed-use developments and transit-oriented models reduce traffic delays and dependence on private vehicles (Tan & Lee, 2018). Conversely, African cities face persistent challenges arising from fragmented land-use policies, weak infrastructure, and limited enforcement (Wong, 2019).

In Nigeria, uncoordinated land development has intensified urban sprawl, traffic congestion, and declining road efficiency (Adeleke et al., 2019; Ogunleye & Adams, 2022). Ilorin metropolis exemplifies these issues. Rapid population growth, expansion of informal settlements, and rising motorization exert mounting pressure on a fragile transport network (Aderamo, 2010). The city's unplanned spatial growth has produced mismatches between land-use concentration and road capacity, resulting in severe congestion at major nodes such as Tipper Garage, Offa Garage Roundabout, and Challenge Junction (Aderamo & Atomode, 2013). Residential, commercial, and institutional land-uses generate diverse trip patterns, yet inadequate infrastructure and poor regulation constrain efficient traffic flow (Olawepo et al., 2020; Olaleye et al., 2022). Concentration of administrative, economic, and educational activities in specific zones further generates high traffic volumes beyond the capacity of existing roads. The consequence is persistent congestion, elongated travel times, increased vehicle emissions, and reduced productivity, which collectively undermine sustainable urban mobility (Ahmed, 2018).

Addressing these challenges requires a deeper understanding of how land-use configurations shape traffic dynamics. Against this backdrop, this study focuses on Ilorin metropolis to provide empirical insights into land-use and mobility interactions. The specific objectives are: (i) to determine the land-use distribution of Ilorin metropolis, (ii) to identify the factors shaping land-use patterns, and (iii) to analyze the pattern of traffic flow across the metropolis. By linking spatial structure with traffic behavior, the study will generate evidence-based recommendations to guide integrated land-use and transport planning strategies for achieving sustainable urban mobility in Ilorin and comparable mid-sized African cities.

## LITERATURE REVIEW

The interrelationship between land-use and transportation dynamics has been the subject of extensive empirical investigations globally. Studies consistently show that the configuration of land-use significantly affects trip generation, traffic flow, and congestion levels in urban environments. (Sugiyama, 2023). Newman and Kenworthy (2016) established a strong inverse correlation between urban density and automobile dependency, demonstrating that sprawling, low-density cities invariably generate higher vehicle miles travelled (VMT) per capita and experience greater congestion than their compact, higher-density counterparts. This global finding has been consistently validated across various contexts, underscoring the principle that spatial structure is a primary determinant of urban mobility outcomes.

The specific mechanisms through which land-use influences traffic flow have been extensively documented. The concept of the "3Ds" – Density, Diversity, and Design; popularized by Cervero and Kockelman (2019), provides a robust empirical framework. Density, measured as population or employment per unit area, concentrates trip origins and destinations, potentially reducing trip lengths but increasing local traffic volumes. Diversity, or land-use mix, refers to the proximity of different functions (e.g., residential, commercial, institutional). When diverse uses are integrated, the potential for shorter, non-motorized trips and multi-purpose journeys increases, thereby reducing the need for long vehicle trips (Ewing & Cervero, 2018). Design encompasses street network characteristics, such as connectivity, block size, and pedestrian infrastructure. Grid-like, connected networks disperse traffic efficiently, while dendritic, hierarchical networks funnel traffic onto arterial roads, creating bottlenecks (Hickman et al., 2023).

In developed regions, empirical applications of integrated land-use and transport planning have yielded promising results. For instance, Jansen and Vos (2018) examined European cities that adopted transit-oriented development (TOD) and found a significant reduction in vehicle kilometers traveled and improved traffic circulation around mixed-use neighborhoods. Likewise, Hong Kong's experience with TOD revealed that high-density land-use arrangements near transport hubs improved traffic flow by encouraging transit ridership and minimizing congestion at urban intersections (Wong, 2019). Singapore's integrated land-use policies further illustrate how strategic planning can harmonize land distribution with traffic efficiency, thereby ensuring sustainable urban mobility (Tan & Lee, 2018).

In developing contexts, however, the situation is markedly different. A comparative study by Mwangangi and Ochieng (2020) on Nairobi, Dar es Salaam, and Kampala found that unregulated urban sprawl

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contributed to traffic congestion and mobility inefficiencies, often compounded by poor road infrastructure. Gebeyehu and Takano (2022) similarly identified rapid and unplanned urbanization in Lagos and Nairobi as a driver of extreme congestion, highlighting how fragmented land-use policies exacerbate traffic flow constraints.

In Nigeria, empirical studies have confirmed the deep connection between land-use patterns and traffic flow inefficiencies. Adaku (2014), examining urban centers across Nigeria, showed that high traffic congestion often coincides with poorly planned residential and commercial clusters. Adeleke et al. (2019) noted that urban sprawl in Nigerian cities has outpaced planning efforts, resulting in inefficient traffic systems and chaotic travel behavior. Focusing on Ilorin, Aderamo (2010) identified the predominance of road-based transport, inadequate integration of land-use zones, and increasing motorization as key drivers of congestion, particularly at major road intersections. More recent work by Olawepo et al. (2020) demonstrated that varying land-use types; residential, commercial, and institutional, generate different levels of trip intensity, with commercial and institutional uses creating the highest traffic volumes.

Similarly, Olaleye et al. (2022) revealed that unregulated expansion of land-use in Ilorin has contributed to congestion, poor traffic management, and inefficient flow patterns. Furthermore, studies by Adedire and Balogun (2019) and Adewumi et al. (2020) on Lagos and Ibadan have consistently found that rapid, unplanned urbanization has led to a profound spatial mismatch. Residential sprawl into peri-urban areas, disconnected from employment centers, forces a dependency on long-distance commutes, while the unchecked conversion of residential properties to commercial uses along major roads

Traffic flow studies in Nigeria have also highlighted the infrastructural and policy dimensions of the problem. Olawuni and Okunlola (2018) observed that land-use encroachment on transportation corridors has worsened congestion in Ilorin, with limited parking facilities and weak traffic regulation aggravating delays. Ibrahim and Lawal (2021) further argued that Nigerian cities lack comprehensive transport data for modeling traffic dynamics, hindering evidence-based planning. In Lagos, the introduction of Bus Rapid Transit (BRT) reduced congestion on certain corridors, yet its success was undermined by fragmented land-use planning (Adedeji, 2020).

Despite the wealth of empirical studies, a significant gap exists in the Nigerian context, particularly in medium-sized cities such as Ilorin. While studies have highlighted the broad challenges of congestion and inefficient mobility (Aderamo, 2010; Adeleke et al., 2019), there is limited research that specifically analyzes how different land-use configurations directly influence traffic flow dynamics at critical urban intersections and corridors. Moreover, existing works often rely on descriptive accounts without integrating spatial analysis and traffic volume studies to model the extent of the relationship. This study, therefore, seeks to fill this gap by empirically examining the interaction between land-use types and traffic flow in Ilorin metropolis, providing evidence-based insights to guide sustainable transport planning.

## STUDY AREA

This research was carried out in Ilorin Metropolis, the capital of Kwara State, Nigeria, situated within latitudes 8°30' and 8°50' North and longitudes 4°20' and 4°35' East. The study area encompasses Ilorin West, Ilorin South, and Ilorin East Local Government Areas, which together form a total of 35 wards (Figure 1) and share both international boundaries with the Republic of Benin to the west and internal borders with Niger state to the North, Kogi State to the East, and Oyo, Ekiti, and Osun States to the South. The land-use pattern is dominated by residential areas, comprising 37.6% of the total land cover and including extensive neighborhoods such as Tanke, Adewole, and Gaa-Akanbi, while commercial and institutional zones, major generators of traffic are concentrated in hubs like Taiwo Road and Ipata Market but remain unevenly distributed. A key urban planning issue is the widespread informal conversion of residential buildings into commercial enterprises along major transport routes, contributing to urban fragmentation and intensified traffic congestion. Transport services within the metropolis are predominantly operated by private individuals, with minibuses, tricycles, and motorcycles serving as the primary modes of public conveyance, while state-run intracity transport is largely nonfunctional and taxis are limited to certain areas.

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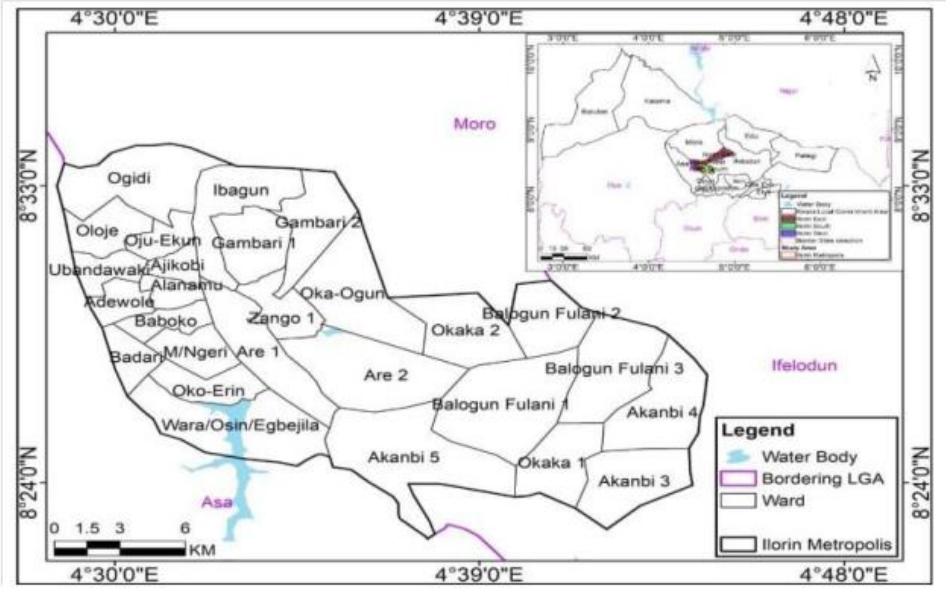


Fig. 1. Administrative Map of Ilorin Metropolis

Source: Olaleye et al. (2022)

## MATERIALS AND METHODS

The data for this study were obtained from traffic survey conducted in Ilorin metropolis. Data were collected through the administration of questionnaires, field observations and. The data required for this study include information on intersection land-use characteristics and road network; traffic volumes and characteristics. These were collected through primary and secondary sources. The primary sources which represent first-hand information were collected through direct field observation and field data collection while the secondary data were collected from high-resolution satellite imagery to extract the current spatial land-use of Ilorin metropolis and the area coverage of each varying land-use.

Multi-stage sampling approach was used to ensure fair representation across the three Local Government Areas (LGAs) that make up Ilorin metropolis for the questionnaire administration. Random sampling was adopted using the balloting technique to randomly select four wards from each LGA namely Adewole, Baboko, Oko-erin, and Warrah/Egbejila/Osin for Ilorin West; Gambari II, Magaji Are I, Ibagun and Zango for Ilorin East; and Ilorin South are Oke-Ogun, Gaa-Akanbi, Okaka and Balogun Fulani. Iincidental sampling technique was adopted to administer the questionnaire where respondents were selected from key land-uses and locations within the sampled wards, focusing on transport hubs including bus terminals, commercial centres/market areas, and public spaces where urban mobility interactions are most pronounced to capture a diverse range of factors determining land-use patterns in Ilorin metropolis. Overall, 344 (86%) questionnaires were completed accurately and were used in the analysis.

Some major intersections were purposively selected and sampled: (1) Offa Garage; (2) Tipper Garage/ Tanke; (3) Challenge; (4) Murtala/Amilegbe; (5) Sawmill/Gerin-Alimi Junction; (6) Surulere/Agbo-oba. A traffic census conducted manually using simple hand-tally method to estimate the volume and composition of traffic at the intersections for peak periods; morning (6-9 am), evening (4-7pm) and off-peak period (12-3pm) for three consecutive days of the week (Monday, Tuesday and Wednesday) of which the average was then used. Principal Component Analysis (PCA) used to analyze the identified factors determining land-use patterns in Ilorin metropolis. The extracted components were analyzed based on their eigenvalues, with only components having eigenvalues greater than 1.0 retained for interpretation.

Multiple Linear Regression was also used to examine the extent to which different land-use types influenced traffic flow rates. This method allowed for the determination of the relationship between traffic flow (dependent variable) and various land-use-related factors (independent variables). This study employed

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statistical software, SPSS, to estimate the regression models. The basic formula for multiple linear regression equation is: $TRF=\alpha_0+\eta\beta_0+\eta_1\beta_1HTF_i+\eta_2\beta_2MSC_i+\eta_3\beta_3HFI_i+\eta_4\beta_4TCR_i + \eta_4\beta_4IEI_i + \varepsilon_{it}$

Where:

TFR – Traffic Flow

HTF – Higher Traffic Flow in Commercial Areas

MSC – Markets and Shopping Centres Causing Traffic Congestion

HTI – Heavy Traffic in Industrial Zones

TCR – Traffic Congestion in Residential Areas

IEI – Impact of Educational Institutions on Traffic Flow

$B_1$- $\beta_5$ – Regression Coefficients

$\alpha_0$– Intercept (constant term)

$\varepsilon$ – Error term

To establish the strength of the relationship between land-use impact factors and traffic flow rate. statistical tests assessed the significance of the coefficients and the model's explanatory power was evaluated using R-squared which further revealed the extent to which different land-use patterns contributed to variations in traffic flow across Ilorin Metropolis. The step-by-step processes in achieving this research are as follows in Figure 2.

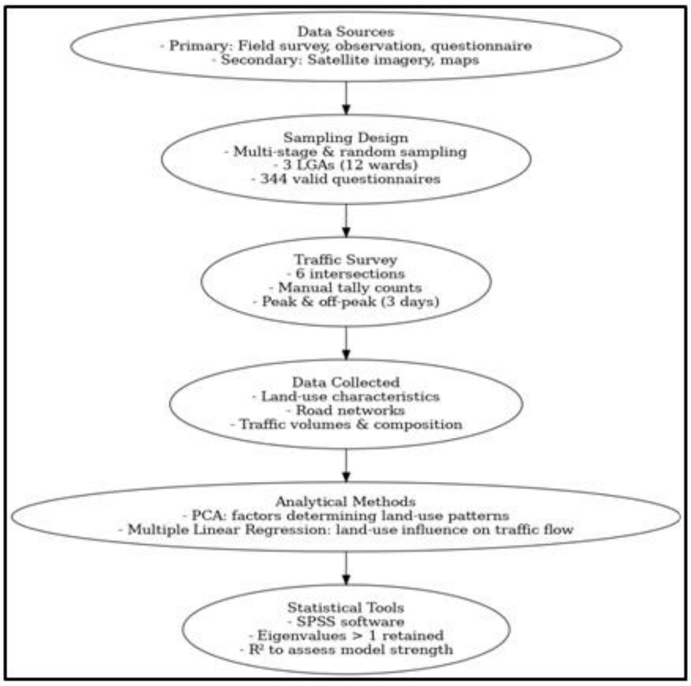


Fig 2. Data Processing Flowchart

Source: Researcher’s Conceptualization

## RESULTS AND DISCUSSION

The results of this study are presented under the following subheading: land-use distribution, factors determining land-use patterns, intersections characteristics and associated land-use, pattern of traffic flow and Multiple Regression Model.

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**Land-use Distribution of Ilorin Metropolis**

The land-use pattern in Ilorin metropolis is characterized by a diverse mix of residential, commercial, industrial, institutional, recreational, agricultural, circulation, and open space allocations as shown in Table 1. Ilorin's land-use is dominated by residential areas (37.6%), followed by circulation networks (21.4%). Commercial (7.8%), institutional (8.4%), and industrial (5.5%) zones are significant but less extensive. A key challenge is the unplanned conversion of residential properties into commercial uses along major corridors like Taiwo Road, which violates zoning regulations, creates mixed-use conflicts, and exacerbates traffic congestion. This haphazard development strains infrastructure designed for lower densities, leading to parking shortages and obstructed vehicular movement. The current spatial organization highlights an urgent need for stricter zoning enforcement and a structured approach to land-use planning to achieve efficiency and sustainability.

Table 1: Land-use Distribution in Ilorin Metropolis

| **Land Use** | **Size (Hectares)** | **Percentage (%)** |
|---|---|---|
| Residential | 15,552.5 | 37.6 |
| Commercial | 3,226.6 | 7.8 |
| Industrial | 2,265.2 | 5.5 |
| Institutional | 3,504.5 | 8.4 |
| Recreational | 1,523.5 | 3.7 |
| Agricultural/Vegetation | 2,750.8 | 6.7 |
| Circulation | 8,855.2 | 21.4 |
| Water Bodies | 1,502.5 | 3.6 |
| Open Spaces | 2,224.6 | 5.3 |
| **Total** | **41,405.4** | **100.0** |

Source: Researcher's Field Survey, 2025

The current spatial land-use structure of Ilorin Metropolis is characterized by a pronounced dominance of residential development, which occupies the largest share of the built-up area, followed by land dedicated to circulation. Crucially, the spatial arrangement reveals a significant disconnect from planned zoning principles. The current spatial land-use in Ilorin metropolis with overlaid road attributes of Ilorin metropolis is depicted in Figure 3.

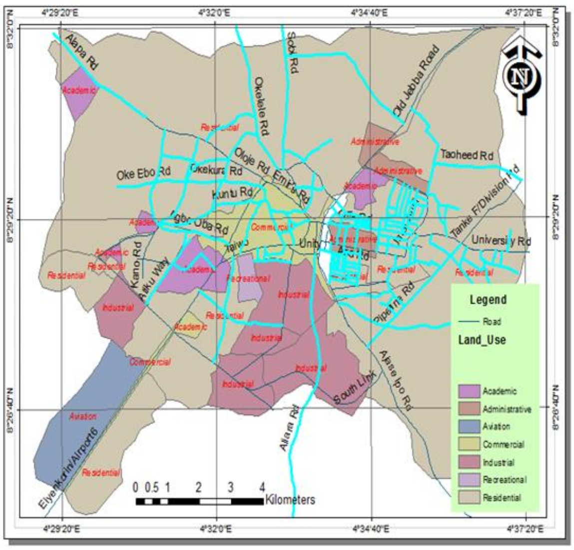


Fig 3. Current Spatial Land-uses and Road Network in Ilorin Metropolis

Source: Researcher's Conceptualization (2025)

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### Mean Ranking of Identified Factors determining the land-use patterns in Ilorin metropolis

Table 2 shows the mean ranking of the identified factors determining the land-use patterns in Ilorin metropolis, this shows that, population density (3.34) is the most critical factor driving land-use change in Ilorin Metropolis, directly intensifying demand for housing and amenities. Infrastructure availability (3.31) ranks second, as access to utilities attracts development. Zoning regulations (3.31) and economic activities (3.27) also significantly influence spatial patterns, though transport accessibility (3.20) is perceived as slightly less decisive. These results underscore that sustainable urban planning must prioritize managing population growth and providing basic services to guide structured and efficient land-use development.

Table 2: Mean Ranking Result of the identified factors determining the land-use patterns in Ilorin metropolis

| **Components** | **N** | **Minimum** | **Maximum** | **Mean** | **Mean Ranking** |
|---|---|---|---|---|---|
| Economic activities: | 344 | 1.00 | 5.00 | 3.2733 | 4th |
| Population density: | 344 | 1.00 | 5.00 | 3.3372 | 1st |
| Accessibility to roads and transport networks: | 344 | 1.00 | 5.00 | 3.1977 | 5th |
| Basic infrastructure availability | 344 | 1.00 | 5.00 | 3.3110 | 2nd |
| Zoning regulations: | 344 | 1.00 | 5.00 | 3.3081 | 3rd |

Source: Researcher’s Analysis, 2025

### Principal Component Analysis on the Factors Determining the Land-use Patterns in Ilorin Metropolis

The PCA results (Table 3) show a Kaiser-Meyer-Olkin value of 0.871, confirming sampling adequacy. Table 4.7b reveals economic activities as the most significant driver of land-use in Ilorin, with an Eigenvalue of 4.077, explaining 81.54% of total variance. This highlights the dominance of businesses, markets, and industries in shaping land distribution. Population density ranks second, contributing 11.91%, reflecting residential and service land demand in densely populated zones. Other factors; accessibility, infrastructure, and zoning account for only 3.45%–1.11%. Thus, planners must prioritize managing commercial growth while balancing population needs, as economic activities overwhelmingly dictate Ilorin’s land-use dynamics.

Table 3: KMO and Bartlett’s Test and Total Variance Explanation

| **Component** | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | **Total** | **% of Variance** | **Cumulative %** | **Total** | **% of Variance** | **Cumulative %** |
| Economic activities: | 4.077 | 81.539 | 81.539 | 4.077 | 81.539 | 81.539 |
| Population density: | .596 | 11.913 | 93.452 | | | |
| Accessibility to roads and transport networks: | .172 | 3.448 | 96.899 | | | |
| Basic infrastructure availability | .100 | 1.991 | 98.891 | | | |
| Zoning regulations: | .055 | 1.109 | 100.000 | | | |
| Extraction Method: Principal Component Analysis. | | | | | | |
| **KMO and Bartlett’s Test** | | | | | | |
| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | .871 | | | | | |
| **Bartlett's Test of Sphericity** | Approx. Chi-Square | 2.067 | | | | |
| | Df | 10 | | | | |
| | Sig. | .000 | | | | |

Source: Researcher’s Analysis, 2025

**Traffic Intersection and Corresponding Land-use**

The studied intersections in Ilorin metropolis on table 4 shows 50% 3-legged (e.g., Offa Garage, Challenge) and 50% 4-legged (e.g., Tipper Garage/Tanke, Surulere/Baboko/Agbo-Oba) are critical yet congested nodes linking residential, commercial, and institutional zones (Table 4). Of all the intersections, only the Muritala/Amilegbe intersection is signalled while others are unsignalized, relying on traffic wardens, and suffer from roadside trading, illegal parking, and poor channelization, causing vehicle conflicts and pedestrian congestion. Major arterials like Ilorin-Ajasse-Ipo Road handle high mixed traffic volumes, while sub-arterials like Tanke-University Road face congestion from informal activities. Land-use intensity (markets, motor parks) exacerbates traffic issues. Addressing these requires upgraded infrastructure, formalized traffic control, and land-use integration to improve mobility and reduce congestion across corridors.

Table 4: Traffic Intersection and Associated Land-use

| S/N | Intersection Name | Road Corridor Name | Road Types | Intersection Type | Land-use Characteristics |
|---|---|---|---|---|---|
| **1** | Offa Garage | Ilorin - Ajasse-Ipo road | Arterial | 3 – Legged | Institutional, Retailing shops, Private and public commercial motor parks, Industrial |
| **2** | Tipper Garage/Tanke | Tanke – University Road | Sub-arterial | 4 – Legged | Retailing shops, Institutional, Commercial motor parks, Government Residential Area. |
| **3** | Challenge Intersection | Post office – Ahmadu Bello Way | Arterial | 3 – Legged | Commercial retail shops, Banks, residential, |
| **4** | Muritala/Amilegbe Junction | Zango – Oke-Oyi road | Arterial | 4 – Legged | Motor-park, Institutional, Offices, Market, Commercial centres, retailing shops, Government Residential Area. |
| **5** | Sawmill/Gerin-Alimi Junction | Gerin-Alimi – Airport – Ogbomoso road | Arterial | 3 – Legged | Institutional, Sawmill industry, commercial motor parks, retailing shops, residential |
| **6** | Surulere/Baboko/Agbo-Oba | General – Baboko – Oja-Oba Road | Sub-arterial | 4 – Legged | Markets, Commercial centres, Institutional, Residential estate, retailing shops |

Source: Researcher’s Field Survey, 2025

**Traffic Flow Pattern in Ilorin Metropolis**

Table 5 analyze the pattern of Traffic volume across Ilorin’s major intersections which reveals Muritala/Amilegbe Junction as the busiest, handling 4,025 vph (19.43%) during morning peak, 4,106 vph (19.40%) in the evening, and 2,263 vph (24.50%) in the afternoon off-peak. This high volume stems from its critical role connecting commercial, institutional, and residential hubs, including Ipata Market, government offices, and hospitals.

Sawmill/Gerin-Alimi Junction follows, recording 3,856 vph (18.62%) in the morning, 3,950 vph (18.66%) in the evening, and 1,570 vph (17.00%) off-peak, serving as a key route for industrial and intercity transport. Tipper Garage/Tanke and Challenge Intersections rank third and fourth, each contributing over 16% of peak traffic with Tipper handling 3,465 vph (16.73%) morning and 3,502 vph (16.54%) evening, and Challenge recording 3,444 vph (16.63%) and 3,495 vph (16.51%), respectively. These nodes link educational institutions, emerging residential areas, and commercial zones.

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Surulere/Baboko/Agbo-Oba and Offa Garage show lower but significant volumes; Surulere handled 3,056 vph (14.75%) morning and 3,210 vph (15.17%) evening, while Offa Garage recorded the least at 2,866 vph (13.84%) and 2,904 vph (13.72%). Evening peaks generally exceed morning volumes, reflecting concentrated return commutes. These patterns underscore the influence of land-use on traffic and highlight urgent needs for improved traffic management, public transport, and infrastructure upgrades to reduce congestion and enhance mobility. Traffic congestion in Ilorin metropolis undermines socio-economic productivity by increasing travel time, transport costs, and fuel consumption, while environmentally it worsens air pollution, greenhouse gas emissions, and noise levels. Similar to other medium-sized African cities like Kisumu (Kenya) and Kumasi (Ghana), Ilorin's congestion reflects rapid urban growth, poor land-use integration, and inadequate transport infrastructure, highlighting shared challenges of balancing mobility, economic efficiency, and environmental sustainability.

Table 5: Pattern of Traffic Composition

| S/N | Intersection Name | Morning Peak (6am – 9am) | | Evening Peak (4pm – 7pm) | | Afternoon Off – Peak (12pm – 3pm) | |
|---|---|---|---|---|---|---|---|
| | | VPH | % of Total | VPH | % of Total | VPH | % of Total |
| 1 | Offa Garage | 2866 | 13.84 | 2904 | 13.72 | 1148 | 12.43 |
| 2 | Tipper Garage/Tanke | 3465 | 16.73 | 3502 | 16.54 | 1559 | 16.88 |
| 3 | Challenge Intersection | 3444 | 16.63 | 3495 | 16.51 | 1542 | 16.70 |
| 4 | Muritala/Amilegbe Junction | 4025 | 19.43 | 4106 | 19.40 | 2263 | 24.50 |
| 5 | Sawmill/Gerin-Alimi Junction | 3856 | 18.62 | 3950 | 18.66 | 1570 | 17.00 |
| 6 | Surulere/Baboko/Agbo-Oba | 3056 | 14.75 | 3210 | 15.17 | 1153 | 12.49 |
| **Total** | | **20712** | **100.00** | **21167** | **100.00** | **9235** | **100.00** |

Source: Researcher's Field Survey, 2025

**Regression Analysis for Varying Land-Use Types Impact on Traffic Flow**

The regression model summary in Table 5 revealed a strong relationship at R = 0.712 between land-use types and traffic flow in Ilorin, with the model explaining 50.7% ($R^2 = 0.507$) of traffic flow variability. However, the relationship between the extent of varying land-use type and traffic flow is statistically significant at p-value (0.000). The regression model significantly predicts the outcome variable, which means the model fits the data.

Table 7 shows that Commercial areas exert the strongest influence ($\beta = 0.786$, $p = 0.000$), significantly driving congestion due to high economic activity. Markets and shopping centres also contribute meaningfully ($\beta = 0.133$, $p = 0.001$). Industrial zones show a positive but statistically insignificant effect ($\beta = 0.088$, $p = 0.065$), while residential ($\beta = -0.020$, $p = 0.713$) and educational ($\beta = 0.008$, $p = 0.888$) areas have negligible impacts. The ANOVA result on Table 6 confirms model significance ($F = 69.540$, $p = 0.000$). These results underscore that commercial and market land-uses are primary congestion drivers, necessitating targeted interventions like improved infrastructure and traffic management. Non-significant effects from other zones suggest their limited role in metropolis-wide traffic patterns, though unmeasured factors like road conditions may also influence outcomes.

Table 6: Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .712[a] | .507 | .500 | .85125 |

a. Predictors: (Constant), Higher Traffic Flow in Commercial Areas, Markets and Shopping Centres Causing Traffic Congestion, Heavy Traffic in Industrial Zones, Traffic Congestion in Residential Areas, Impact of Educational Institutions on Traffic Flow

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Table 7: ANOVA[b]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 251.957 | 5 | 50.391 | 69.540 | .000[a] |
| | Residual | 244.927 | 338 | .725 | | |
| | Total | 496.884 | 343 | | | |

a. Predictors: (Constant), Higher Traffic Flow in Commercial Areas, Markets and Shopping Centres Causing Traffic Congestion, Heavy Traffic in Industrial Zones, Traffic Congestion in Residential Areas, Impact of Educational Institutions on Traffic Flow

b. Dependent Variable: Traffic flow

Table 8: Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .030 | .277 | | .108 | .914 |
| | Higher Traffic Flowing Commercial Areas | .786 | .043 | .726 | 18.463 | .000 |
| | Markets and Shopping Centres Causing Traffic Congestion | .133 | .039 | .136 | 3.450 | .001 |
| | Heavy Traffic in Industrial Zones | .088 | .048 | .090 | 1.853 | .065 |
| | Traffic Congestion in Residential Areas | -.020 | .054 | -.022 | -.368 | .713 |
| | Impact of Educational Institutions on Traffic Flow | .008 | .060 | .008 | .141 | .888 |

. Dependent Variable: Traffic flow

## CONCLUSION AND RECOMMENDATION

This study conclusively demonstrates that land-use configuration is a fundamental determinant of traffic flow dynamics in Ilorin Metropolis revealing critical implications for sustainable transport planning, with commercial and market-related activities being the primary drivers of congestion. The spatial dominance of residential areas (37.6%), followed by circulation networks, is critically misaligned with traffic generators, as evidenced by intense congestion at major unsignalized intersections like Muritala/Amilegbe and Tipper Garage handling high traffic volumes, with morning and evening peaks consistently straining infrastructure.

Poor traffic control, illegal roadside activities, and absence of signalized junctions worsen flow efficiency. Principal Component Analysis (KMO = 0.871) identified economic activities as the paramount driver (81.54% variance) of land-use patterns followed by population density (11.91%), a finding directly reflected in the regression results which confirmed commercial areas ($\beta = 0.786$, $p = 0.000$) and markets ($\beta = 0.133$, $p = 0.001$) as the most significant predictors of traffic congestion while residential, industrial, and educational land-uses exert minimal or statistically insignificant effects. This confirms that thriving commercial activities dictate the distribution and utilization of land, intensifying traffic generation around major hubs.

The haphazard conversion of residential properties to commercial uses along major corridors like Taiwo Road creates severe land-use conflicts, exacerbates traffic inefficiencies and undermines sustainable mobility while the concentration of institutional and commercial functions funnels high traffic volumes onto a network incapable of efficient accommodation, leading to the observed peak-period gridlocks. Also, the concentration of economic activities in key zones without corresponding transport infrastructure upgrades leads to severe congestion at critical intersections, prolonged travel times, and increased environmental impacts.

The findings collectively imply that Ilorin's traffic problems are rooted in weak land-use planning, overconcentration of economic activities, and infrastructural deficits. Addressing these issues requires integrated land-use and transport strategies that balance economic growth with sustainable mobility. To foster sustainable transportation planning, the following key recommendations were proposed:

1. Implement integrated land-use and transport policies that promote mixed-use development to shorten trip lengths and reduce vehicle volumes on arterial roads and enforce strict zoning regulations to curb unplanned commercial conversions along arterial roads.
2. There should be prioritization to modernize critical intersections with traffic signals, improved channelization, and dedicated pedestrian facilities. Furthermore, develop a formalized public transport system to mitigate reliance on private vehicles.
3. establishment of secondary commercial hubs across the metropolis should be promoted to help redistribute traffic demand, reduce pressure on central corridors, and promote spatial balance.
4. There should be heavy investment in sustainable and reliable public transport (e.g., BRT, regulated minibuses) to complement land-use policies, reducing dependence on private vehicles and easing congestion across major corridors.

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