Traffic Assessment for Sustainable Urban Mobility in Ile-Ife, Osun State, Nigeria

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Abstract

Urban traffic congestion remains a critical challenge in developing countries, where rapid urbanization often outpaces infrastructure development. This study investigates traffic congestion in Ile-Ife metropolis, Nigeria, using geospatial techniques to map street corridors, identify traffic patterns, and propose alternative routes for sustainable urban mobility. Primary data were collected through manual traffic counts, GPS mapping, and road inventories, while secondary data included Bing satellite imagery and GRID3 shapefiles. Analytical methods such as buffer analysis and network analysis were applied using ArcGIS 10.8.

Results indicate that congestion is concentrated in commercial and institutional zones, notably Mayfair, Lagere, Sabon Market, and OAUTHC, with peak delays during morning and evening rush hours. Motorcycles and tricycles dominate traffic flows, underscoring the reliance on informal transport systems, while heavy vehicles contribute to prolonged delays in narrow corridors. Weekly traffic trends reveal mid-week peaks driven by market and institutional activities, with off-hour congestion persisting due to overlapping socio-economic functions. Geospatial mapping identified alternative routes, including Eleyele, Oranfe, and Ife Polytechnic corridors, which offer potential relief during peak periods.

The study concludes that traffic congestion in Ile-Ife is multi-dimensional, shaped by socio-economic rhythms, modal distribution, and infrastructure limitations. Limitations include reliance on short-term manual counts and limited behavioral analysis of informal transport. Recommendations emphasize improved infrastructure, regulated informal transport, designated parking, and GIS-based traffic management systems to achieve sustainable urban mobility.

Keywords:
Traffic congestion, Geospatial analysis, Sustainable urban mobility, GRID3, Corridor.

Introduction

Urban mobility plays a pivotal role in shaping the socio-economic development and environ--mental sustainability of cities worldwide. In many developing countries, including Nigeria, rapid urbanization and population growth have led to increased demand for transportation services, often without corresponding improv--ements in infrastructure and traffic managm--ent systems (Pucher,2007). This mismatch has resulted in severe traffic congestion, environmental pollution, road accidents, and declining quality of life for urban residents. Sustainable urban mobility has thus emerged as a critical focus for policymakers, urban planners, and researchers seeking to balance transportation efficiency, environmental preservation, and social equity. Sustainable urban mobility emphasizes the development of transport systems that meet the needs of the present without compromising the ability of future generations to meet their own transportation needs. It promotes the integration of various transport modes, encourages the use of public and non-motorized transport, supports traffic demand management, and ensures that mobility systems are inclusive, safe, and environmentallysustainable (Mavlutova,2023).

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Ile-Ife, a historical and culturally significant city in Osun State, Nigeria, has experienced significant urban expansion over the past few decades. This expansion has been accompanied by a corresponding rise in vehicular traffic, particularly in the central business districts like Mayfair commercial area, Sabon-market known as Oja, Lagere along Remo and banking areas, Phase 1 and phase 2 Obafemi Awolowo Teachings hospital and other residential neighborhoods are hotspot zone for traffic congestion in Ile-Ife (Ajala,2013). However, the city's road network and traffic management systems have not kept pace with this growth, leading to increased travel delays, fuel consumption, and greenhouse gas emissions. These challenges underscore the urgent need for a comprehensive assessment of traffic conditions in Ile-Ife as a foundation for promoting sustainable urban mobility.

A traffic assessment provides critical insights into the patterns, volume, and flow of vehicles within an urban area. Such assessments are essential for identifying bottlenecks, evaluating the adequacy of road infrastructure, and proposing effective interventions such as road expansions, traffic signal optimization, non-motorized transport promotion, and public transit enhancements (Olojede, 2024). In the context of Ile-Ife, where informal transport systems like motorcycles and tricycles complement conventional vehicular traffic, a holistic understanding of traffic dynamics is crucial for formulating sustainable mobility solutions that cater to the needs of diverse road users. The dynamics of traffic congestion in Ile-Ife are compounded by a unique blend of formal and informal transport systems. Private cars and commercial buses coexist with a dominant informal sector, including motorcycles (okadas) and tricycles (keke), which account for a significant share of urban trips due to their affordability and maneuverability (Ajayi,2013).

This mix contributes to congestion through lane indiscipline, unregulated parking, and competition for limited road space. Poor road conditions marked by potholes and narrow widths exacerbate delays, while roadside markets and pedestrian activity further constrict flow. Unlike larger cities like Lagos or Ibadan, Ile-Ife lacks advanced traffic management systems or mass transit options, relying instead on rudimentary controls like traffic wardens, which are often overwhelmed during peak hours (e.g., 7–9 a.m. and 4–6 p.m.). The impacts of congestion in Ile-Ife extend beyond mere inconvenience. Economically, it increases transport costs, delays goods delivery, and reduces productivity, particularly for small businesses and traders reliant on daily mobility (Ajayi *et al*., 2017). Socially, it fosters stress, reduces quality of life, and limits access to essential services like healthcare and education. Environmentally, idling vehicles heighten air pollution and noise levels, posing health risks in a city with limited green infrastructure. Oladejo (2024) highlights the causes poor road network infrastructure and driver behavior but the study focuses on larger metros unlike Ile-Ife's specific cultural and transport context. Studies by Ukpata and Etika (2012) across Nigerian cities highlight how narrow roads and unregulated parking exacerbate delays, a pattern evident in Ile-Ife's bustling commercial and academic zones. The aim of this research is to assess traffic congestion for sustainable urban mobility in Ile-Ife metropolis using geospatial technique. The respective objectives are to; map the street corridors and critical junction contributing to traffic congestion in Ile-Ife; identify traffic patterns for selected location in the study area and identify alternative routes to reduce congestion and improve accessibility in the study area.

Study Area

The study area is Ile-Ife, Osun state, Nigeria, and it encompasses of Ife Central local government, Ife East local government, Ife North local government, and Ife South local government. Ile-Ife is located between latitude 70o 28'0" N and 70o 45'0" N and longitude 40o 30'0" E and 40o 34'0" E, Ile-Ife lies to the west of Ibadan, and lies to the east of Akure (Figure 1). The area spanned over 1,894.06km2 approximately 80 kilometers towards Ibadan and connected to it via the Ife-Ibadan highway and home to 500,000 people with large population of women and children. Ile-Ife has population of 167,254(NPC,2006). And it comprising of 84,653 males and 82,601 females while Ife East has an estimated population of 188,087; comprising of 92,054 male and 96,033 Female. [NPC, 2006]. The people of Ife are descendants of Oduduwa but with other tribes like Igbo, Hausa and others resides around the community and its

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environs. Ile-Ife is home to one of the popular and ancient university in Nigeria known as Obafemi Awolowo University and also the seat of the spiritual head of Yoruba people "Oni of Ife" who has custody of the sacred staff of Oranmiyan, an 18-foot granite monolith in the shape of an elephant's tusk.

Ile-Ife falls within the humid tropical environment and therefore has high temperature and rainfall. It is characterized by marked wet and dry seasons (Adejuwon, 1979). The wet season which is associated with the tropical airmass varies between seven and nine months. It lasts from around April to November. The annual rainfall variability lies between 90% and 120% annually. The dry season is associated with the tropical continental airmass (cT), temperature and relative humidity are generally high. The mean monthly temperature ranges between 23°C and 27°C (Ojo, 1977). This climate supports the rainforest formation as described by Richards (1952). In the dry season, the temperature can be as high as above 29.4°C and in the rainy season it can be as low as 25.6°C. The relative humidity is very high between 67% and 88%. The dry season usually begins towards the end of October and ends around March thus, lasting five months. The rainy season begins around April and ends in October. Ile-Ife is located within the rain forest belt of Nigeria where the climate encourages forest growth. Its forest cover supports the growth of cash crops such as Cocoa, kolanut and Oil Palm. Ife Area generally is the home of valuable economic timber resources such as Iroko, Oganwo, Obeche, Idingbo, Afa, and Ole making lumbering and saw-milling a major industry in the area. The town is also a collecting center for agricultural products which has attracted traders from Northern Nigeria to settle and trade especially in kolanut.

The city's transport infrastructure reflects a mix of historical planning and modern adaptation. Major corridors, including Ilesha Road (a dual-lane arterial route), Lagere (a narrower commercial artery), and OAU Teaching Hospital Road, form the backbone of Ile-Ife's Road network, connecting residential, academic, and market zones. Junctions like OAU Gate and Mayfair serve as critical nodes where traffic converges, often exceeding capacity during peak hours from 7 to 9 a.m. and 4 to 6 p.m. Bus stops, notably at Sabo Market and near OAU, facilitate informal transit systems dominated by okadas, tricycles, and minibuses, which account for a significant portion of daily trips. Road widths typically range from 6 to 10 meters, with many sections unpaved or poorly maintained, as noted in regional studies by Ukpata and Etika (2012), contributing to congestion hotspots. Ile-Ife's economic base, rooted in trade, education, and small-scale agriculture, shapes its traffic patterns. Markets like Sabo and Enuwa draw vendors from surrounding rural areas, while OAU's academic calendar dictates peak flows, particularly during semester beginnings and ends. Historical sites, such as the Ooni's Palace and Ife Museum, add tourist traffic, though less impactful than daily commuting. This study concentrates on the urban core and its immediate periphery, leveraging GIS to map these corridors, junctions, and bus stops, capturing the interplay of geography, population, and infrastructure that defines Ile-Ife's traffic challenges.

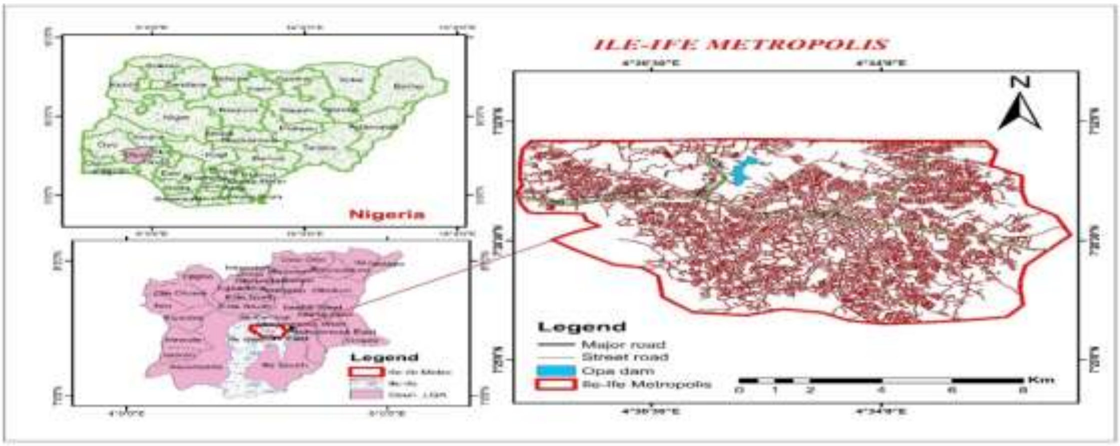

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Figure 1: The Study Area

Literature Review

This research explored three major theories as its guide in the research among other theories relating to similar researches. Traffic Flow Theory, pioneered by Bruce Greenshields in 1935 and later refined by Salter and Hounsell (1996), provides a foundational model for understanding vehicular movement through the interplay of flow, density, and speed. Greenshields introduced the linear speed-density relationship, formalized as Q = K * V, where Q represents flow in vehicles per hour, K denotes density in vehicles per kilometer, and V indicates speed in kilometers per hour. This macroscopic approach, inspired by fluid dynamics, illustrates that flow peaks at an optimal density before declining as congestion emerges, reducing speed and paralyzing networks. On major corridors like Lagere and Ilesha Road in Ile-Ife had recorded high peak hours traffic counts, revealing choke points where flow disrupts. Junctions such as OAU Gate and bus stops near Sabo Market are critical nodes where density spikes, measurable through field data, impact overall movement.

The second was Network Theory, originating with Euler's 18th-century graph theory and advanced by Newman (2010) in complex systems research, conceptualizes urban transport as a graph comprising nodes and edges. In Ile-Ife, major roads such as Ilesha Road and Lagere serve as edges, while junctions like OAU Gate and bus stops at Sabo function as nodes critical to connectivity and flow efficiency. Centrality measures degree, indicating connections per node, and betweenness, marking nodes on shortest paths highlight congestion-prone points; OAU Gate, linking the university, likely exhibits high traffic due to its multiple connections. Mapping these elements through GIS plots edge lengths, such as the 2-kilometer stretch from OAU to Mayfair, and node densities around key areas. This approach structures data into attributes like node traffic volume and edge capacity, enabling queries about overburdened points. Shortest-path algorithms, such as Dijkstra's, calculate bypasses, such as a 1.5-kilometer detour around Mayfair, reducing travel time across the network. Evolving from Euler's Seven Bridges of Königsberg problem, Network Theory matured into a tool for modern infrastructure analysis, with Newman's updates incorporating weighted edges based on factors like road width, typically 7-10 meters in Ile-Ife.

Sustainable Transport Theory was the third theory explored, it was articulated by David Banister (2008), emerged from 1990s environmental planning discourses, notably the Brundtland Report (1987), advocating mobility that balances ecological and social costs with accessibility. It critiques car-centric urban growth, a trend evident in Nigeria's post-independence cities like Ile-Ife, and emphasizes optimizing existing infrastructure over expansive new builds. Mapping corridors like OAU Teaching Hospital reveals overused segments, guiding targeted upgrades. Junctions and bus stops, such as those at Sabo, serve as leverage points; enhancing capacity could reduce idling emissions significantly. This theory supports cataloging sustainability indicators CO_2 emissions or noise levels into a GIS framework, facilitating evidence-based planning.

There had been a growing literature both empirical and theoretical studies in the area of traffic congestion and urban mobility in many countries of the world and some of these reviews are relevant to this study. However, Ajayi *et al.* (2017) investigated traffic congestion on major roads in Minna, Niger State, Nigeria, with the use of geospatial technique to assess infrastructure deficiencies and proposing remedial actions. The study used 1m high-resolution IKONOS satellite imagery and hand herd GPS boasting an accuracy of ±5 meters to map arterial routes such as Kpakungu-Gidan, Kwano Road and Bosso Road, spanning a 15-kilometer network. The study revealed that traffic counts over two weeks recorded peak flows of 3,200 vehicles per hour in Kpakungu, with congestion reaching unstable flow conditions at speeds of 30 to 40 kilometers per hour. Narrow carriageways measuring 5 to 7 meters and degraded asphalt surfaces, 30 percent of which were potholed, emerged as primary causes.

Aftabuzzaman *et al.* (2010) quantified the congestion relief benefits of public transport across 10 global cities, including Tokyo, using econometric models on 500 kilometers of networks. Bus priority lanes reduced delays by 15 to 20 percent, with Tokyo achieving annual

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savings of $27 billion, although the study focuses on formal transit systems differs from Ile-Ife's mixed traffic, and the absence of GIS tools limits spatial insights. Meanwhile, Adebayo *et al*. (2021) studied traffic flow in Port Harcourt, Nigeria, using traffic counts over a month on Aba Road high way,the study revealed that traffic congestion recording 3,800 vehicles per hour during peak periods. Congestion stemmed from narrow widths of 7 to 9 meters and heavy truck traffic, with delays averaging 25 minutes per kilometer.

Adetunji *et al.* (2022) investigated traffic congestion in Osogbo, Nigeria, near Osun State University, using traffic counts over two weeks, the study records 2,600 vehicles per hour. Narrow roads of 6 to 8 meters and student-related traffic caused delays of 22 minutes per kilometer, with proposals for bypasses and signal upgrades.

In the same vein, Babalola *et al.* (2019) examined road traffic congestion in Lagos, Nigeria, using manual counts and questionnaires across 12 major corridors, recording peak volumes of 4,500 vehicles per hour. Narrow roads averaging 8 meters and commercial activity near markets like Oshodi drove delays of 30 minutes per kilometer, recommendations include road widening and traffic signal installation, though the lack of GIS tools constrained spatial precision, their findings highlight congestion drivers in Nigerian urban settings.

The body of research reviewed provided wealth of insights into traffic congestion, geospatial analysis, and urban transport planning, yet significant gaps persist that this study seeks to address in the context of Ile-Ife. Studies by Oyekola *et al*. (2020) and Ajayi *et al*. (2017) offer robust geospatial methodologies for mapping congestion in Nigerian cities like Ido and Minna, revealing infrastructure deficits such as narrow roads and high vehicle volumes. However, comprehensive mapping of street corridors in Ile-Ife, including detailed assessments of Lagere and Ilesha Road, remains uncharted, leaving a critical void in understanding this city's specific traffic landscape. Similarly, Ogunbodede (2006) and Onuigbo *et al.* (2019) advance the use of GIS databases and route planning in Akure and Minna, demonstrating the power of spatial tools to catalog traffic data and propose bypasses. Yet, these studies overlook the systematic documentation of junctions and bus stops, such as OAU Gate and Sabo, which are pivotal to Ile-Ife's traffic dynamics, and their applicability to mid-sized urban centers like Ile-Ife requires further exploration.

Methodology

The study passes through four stages, the first stage was the reconnaissance survey of the selected five traffic congestion in the study area, secondly, the collection of data, thirdly the analysis of data, and the last stage was the discussion of findings**.** The comprehensive methodology combines both quantitative and qualitative approaches to examining the current pattern of traffic congestion in Ile-Ife metropolis and mapping of street corridors, critical junction contributing to traffic congestion in study area. The integration of multiple data sources, advanced analytical techniques, and stakeholder engagement ensures a robust and holistic assessment of the challenges and opportunities presented by traffic congestion in the study area.

Sources of Data

The study used both primary and secondary to achieve its objectives. The primary data includes data from field survey, manual traffic count, road inventory and hand-held GPS device were used in order to gather quantitative data on traffic congestion as well as to access the coordinate of traffic location in the study area. The secondary data includes Bing satellite data 0.5m resolution was obtained from Esri OpenStreetMap. OpenStreetMap (OSM) is a free satellite imagery comprises of open map database updated and maintained by a community of volunteers via open collaboration where contributors collect data from surveys, trace from aerial photo imagery or satellite imagery and imported from other freely licensed geodata sources (Oyekola *et al*. 2020).

OpenStreetMap is freely licensed under the Open Database License and is commonly used to make electronic maps, inform turn-by-turn navigation, and assist in humanitarian aid and data visualization. OpenStreetMap uses its own data model to store geographical features such point features, line features and polygon features which can then be exported into other GIS file formats. Although Bing Maps was originally launched as MSN Virtual Earth, which was released for better testing on July

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24, 2005. It was a continuation of previous Microsoft technologies such as Microsoft MapPoint and TerraServer. This imagery helped to map out open space and other geographic features within the study area. The research also obtained administrative boundary shapefile from GRID3 (Geo-Referenced Infrastructure and Demographic Data for Development) is a program focused on generating, validating, and using high-resolution geospatial data on population, settlements, infrastructure, and boundaries. This data is crucial for informed decision-making in various sectors, including health, infrastructure development, and humanitarian response. GRID3 works with countries to build national capacity for collecting, analyzing, and utilizing this data, ensuring its sustainability and impact.

Data Collection procedures

Data collection was executed in two distinct phases: field-based primary data gathering and desk-based secondary data acquisition. In the field phase, GPS device was deployed to map the selected locations of traffic congestion in Ile-Ife metropolis, recording coordinates at 100-meter intervals along roads and at the center of each junction and bus stop. Traffic counts were performed at the specific points during peak hours (7-9 a.m. and 4-6 p.m.) on weekdays, using tally sheets to document vehicle types and numbers, and stopwatches to measure delay times, averaging data across three days per point. Road widths and junction dimensions were measured using 50-meter tapes at each site, supplemented by photographic documentation for verification. The secondary data phase involved downloading of 2025 Bing satellite imagery of Ile-Ife at 0.5-meter resolution, grid data with already georeferenced location.

Data Analysis technique

Network analysis and proximity analysis such as buffer analysis and road network analysis were used to assess the traffic congestion of the study area. However, buffer of 100 meters on both sides of the road was done in order to map the street corridors and critical junction contributing to traffic congestion in Ile-Ife metropolis using a high-resolution satellite imagery of 0.5m from OpenStreetMap (Esri). It was georeferenced and digitized in order to map geographic features such road, building, open space and recreational area. Road Network Analysis is the process of using geospatial tools and mathematical algorithms to examine, interpret, and model the structure and functionality of road systems. It involves understanding how roads connect, how people and goods move through them, and how to optimize this movement for efficiency, safety, or sustainability. While, the buffering analysis is the process of generating a new polygon layer that represents a zone around a geographic feature based on a given distance. It is commonly used in proximity analysis to answer questions like: What is within 500 meters of a river? "Which schools are within 500 meters of a major road? "From there, road shapefile was created using projected coordinate system and other features such as sporting site, bus Stop, leisure and public relaxation, public events and large gatherings, schools, health facilities, car park, open Market, farming and regulated area within the 500-meter buffered zone in Ile-Ife. We used network analysis to identify the alternative route within the traffic congestion area such as shortest route to overcome traffic congestion.

Data Analysis Procedures

We imported a georeferenced Bing satellite imagery through the add tool of ArcGIS environment and clipped the satellite imagery using the Ile-Ife metropolis's shapefile, we set our coordinate system to projected coordinate system (WGS UTM zone 32) and navigated straight to catalog to create the folders in order to map features such as road and other geographic features. From there, we created shapefiles for all the point, line and polygon features within the study area, thereafter we manually digitize all the street and major roads in the study area using the ArcGIS editor tool. However, we buffered the major road along traffic congestion 500 meter both sides in order to map the physical features within the street corridors and critical junction contributing to traffic congestion in Ile-Ife. Some of these features are sporting field, bus Stop, green area, public events and large gatherings, schools, health facilities, car park, open Market, farming and regulated area.

Software

i). This ArcGIS 10.8 software is highly effective in assessment of traffic congestion research studies due to its advanced geospatial

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capabilities and user-friendly interface. However, with respect to this research study, ArcGIS software 10.8 version was used for digitizing, network analysis, map composition, change of projection and as well as the preparation of the study area map. ArcGIS is a geographical information system (GIS) software that allows handling and analyzing geographic information by visualizing geographical statistics through layer building maps like traffic flow. It's used by a whole host of academic institutions and departments, both in the humanities and sciences, to develop and illustrate groundbreaking research. Further, it is used by several governments and private/commercial institutions worldwide.

ii.) Microsoft Excel 2016: Microsoft Excel is essential for tabular analysis due to its simplicity, versatility, and robust data analysis tools. Micro software excels in regards to this study, was used to summarize some descriptive statistics such as traffic delay time, causes of traffic and some other tabular display as well as plotting of chart and some parametric statistics. Microsoft Excel is a spreadsheet program that allows users to organize, analyze, and calculate data. It's part of the Microsoft Office and Microsoft 365 suites of software.

Hardware

i.Global Positioning System (GPS Receiver)
ii.Field Book
iii.Computer (HP Core i7,8GB RAM): For data processing
iv.Traffic count sheet
v.Measuring Tape

The general methodological flow chart is as shown in Figure 2 below.

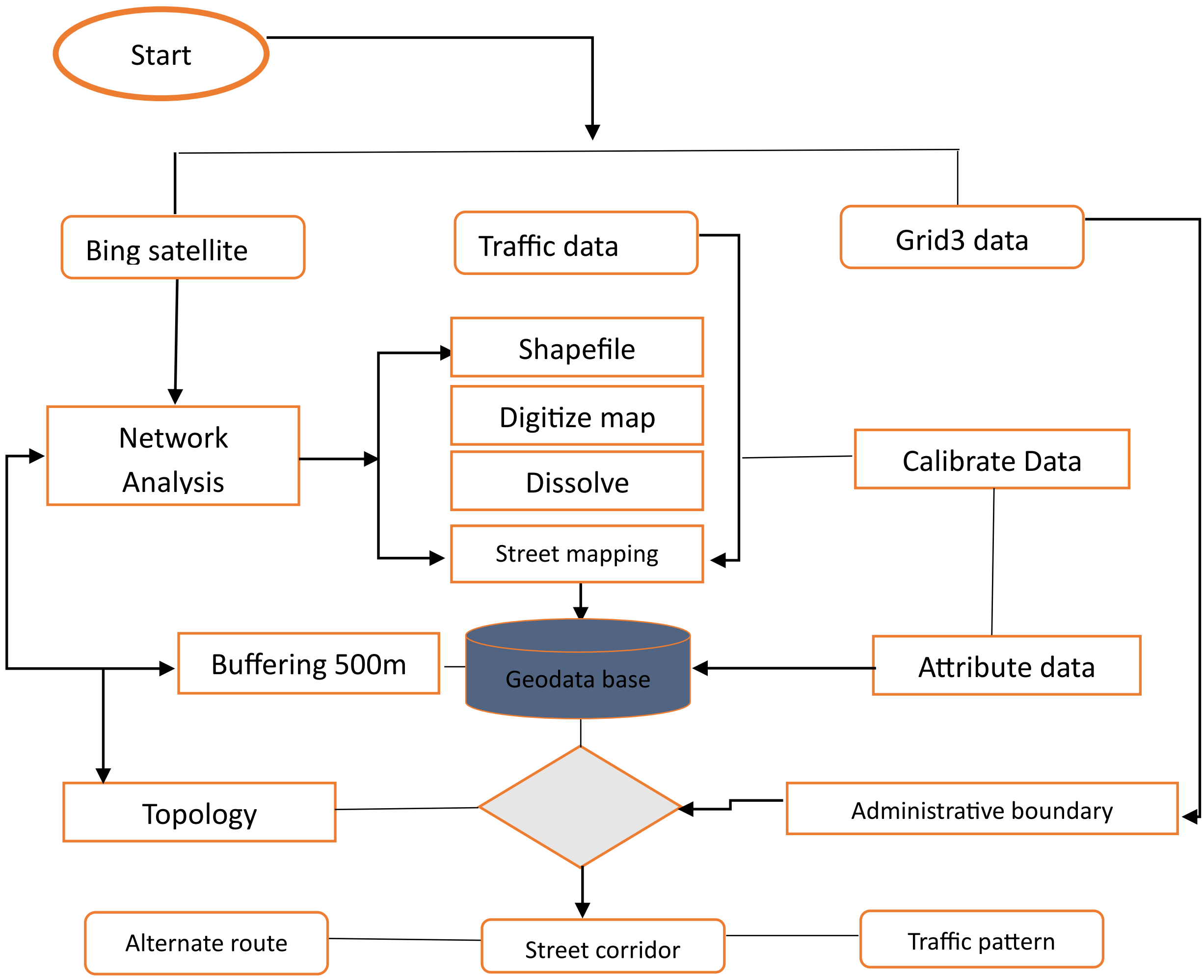

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Figure 2: Methodological Flow Chart

Results and Discussion

Mapping the Street Corridors and Critical Junction contributing to Traffic Congestion in Ile-Ife

Mapping of street corridors along the traffic congestion in the study area, was done through buffered 100m on both sides of the road to assess features and critical junctions that are key points to where two or more major roads intersect, often acting as hotspots of traffic congestion. In Ile-Ife, congestion is commonly observed at business areas and where roads intersect such as Mayfair roundabout, Lagere banking area, Sabon Oja market and Obafemi Awolowo University Teaching Hospital. These areas serve as nodal points for commuters moving within the city and those traveling to other parts of Osun State. The limited capacity of these junctions, coupled with poor traffic management practices, street trading, inadequate parking facilities, and non-compliance with traffic rules, intensify congestion levels. In Ile-Ife traffic congestion often happened along the same corridor of the metropolitan road as showed in Figure 3. The study was able to map out features such as roads, open space, car parks, shops, junctions and other relevant features that are within the 100m buffer corridors of the study area which are showed in Figures 4, 5, 6 and 7 and also as shown in Table 1. Thess results agreed with the study by Sjafril *et al.*, (2018) on Eco-design concept of street corridors as a city image forming, the study uses a qualitative descriptive method, describing secondary data from research journals about the concept of eco-design. The study's conclusion shows that the urban road corridor landscape can be arranged and improved with an eco-design concept strategy to improve the image of the city towards a sustainable city.

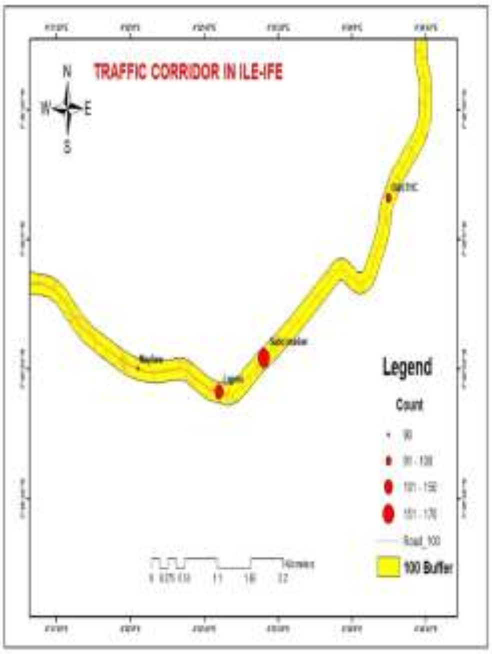

Figure 3: Traffic Corridor in Ile-Ife Metropolis Source: (Researchers,2025)

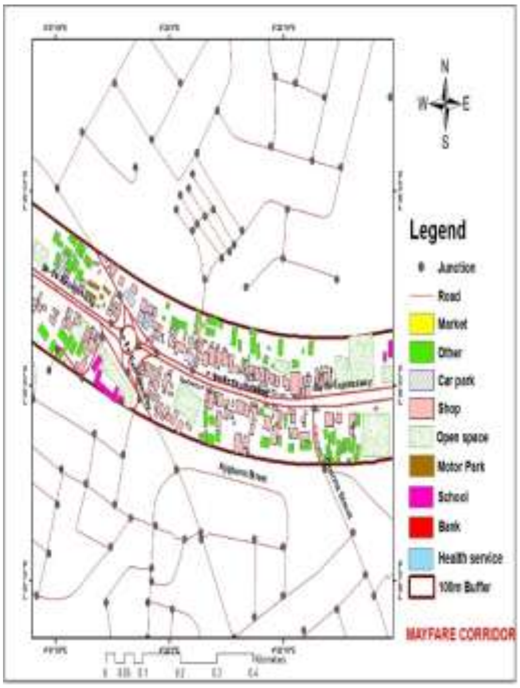

Figure 4: Street Corridor Along MayFare Business area of Ile-Ife

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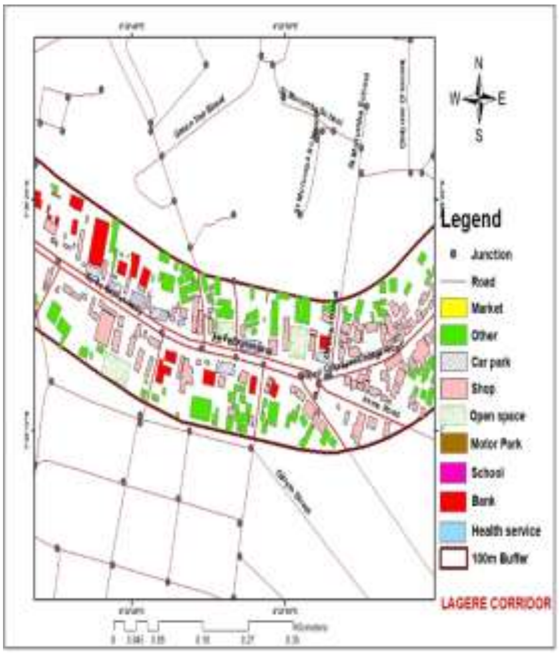

Figure 5 Street Corridor Along Lagere Banking area of Ile-Ife
Source:(Researchers,2025)

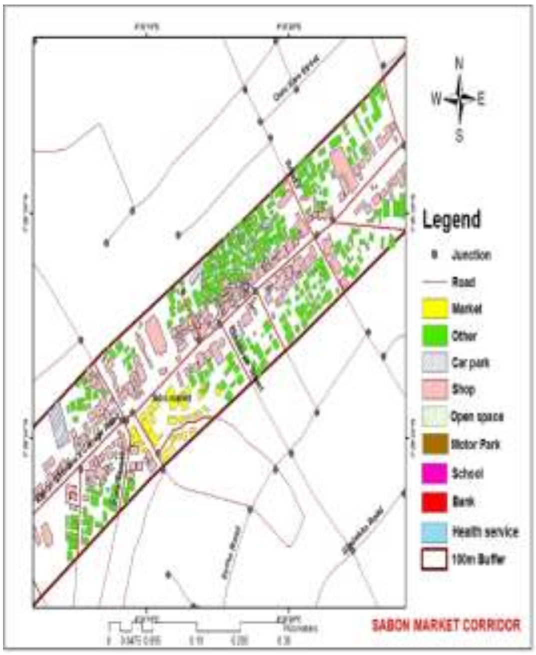

Figure 6 Street Corridor Along Sabon-Oja market area of Ile-Ife

Source:(Researchers,2025)

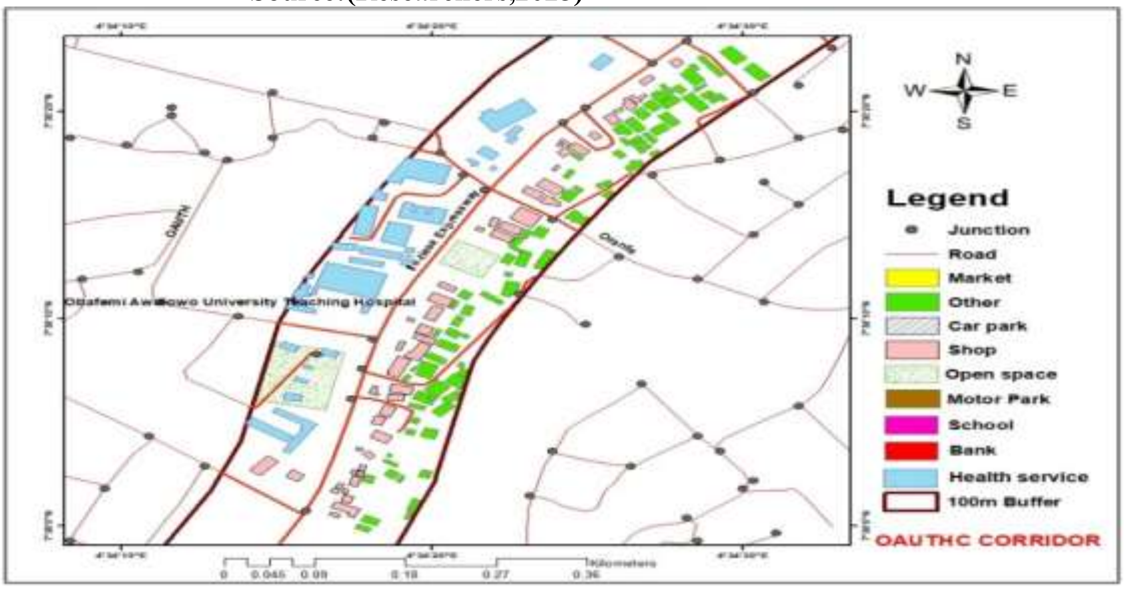

Figure 7: Street Corridor Along Obafemi Awolowo University Teaching Hospital, Ile-Ife Source:(Researchers,2025)

Table 1: Street Corridor Statistics within 100m buffered in Mayfare, Lagere, Sabon and OAUTHC, Ile-Ife

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S/NO	Location	Road	Junction	Shop	Car park	Bank	Open space	Other
1	Mayfare	5	10	121	6		4	164
2	Lagere	8	15	156	12	11	2	108
3	Sabon Market	9	17	208	2		1	128
4	OAUTHC	7	9	64	2		2	98

Source:(Researchers, 2025)

Identification of Traffic Patterns for selected Location in the Study Area

Identifying traffic patterns in relation to location, direction, and time was mapped in the areas such as the Obafemi Awolowo University Teaching Hospital and the Lagere banking district exhibit distinct congestion trends influenced by the socio-economic activities occurring there according to daily schedules. At the Teaching Hospital, peak hours traffic congestion was observed when office-related movements overlap with academic activities, particularly during morning office resumption and student school runs. Congestion typically occurs between 8:00 to 8:45 a.m. and again during the evening off-hours from 4:30 to 5:10 p.m. Traffic congestion around Sabon Oja market is primarily caused by intense commercial activities and the absence of designated parking spaces, which forces motorists to park along both sides of the road. Additionally, the presence of heavy vehicles such as Dangote trucks and oil tankers contributes to the problem, as they frequently use the route despite its narrow width of only 5.6 meters. The construction of the flyover at Lagere and its surrounding areas has compelled motorists to divert through alternative routes, particularly towards Eleyele, Paraki, Sabon market, and other locations along those corridors. Table 2 and Table 3 showed the traffic patterns of the study area. Whereas Adewuyi (2019) carried out a Geospatial Analysis and Assessment of Traffic Congestion on Major Road in Ibadan North Local Government Area, Oyo State, Nigeria. The study used direct interviews and questionnaires to carry out the analysis, the study revealed that traffic congestion were caused by traffic warden, accident, roadside-hawking, vehicle-breakdown, double packing, roadside-packing, inadequate road capacity, absence of walkways, traffic light malfunctioning and pot holes while the effects of the traffic congestion are extra fuel consumption, reduction in working hour, less productivity, late/missed appointment, inability to forecast travel time and extra time consumption.

Traffic Congestion Peak Hours

Table 2 highlights the peak hours of traffic congestion across Mayfair, Lagere, Sabon Market, and OAUTHC. The data shows that congestion is most pronounced during morning and evening rush hours, particularly between 8:00–8:45 a.m. and 4:30–6:30 p.m. These periods coincide with office resumption, school runs, and market closures, reflecting the socio-economic rhythms of Ile-Ife. For instance, Lagere experiences congestion in the morning (8:00–8:45 a.m.) and evening (4:30–5:10 p.m.), while Sabon Market records afternoon congestion (3:30–3:45 p.m.) due to intense trading activities. This pattern aligns with Adewuyi (2019) findings in Ibadan, where traffic congestion was strongly linked to institutional schedules, roadside hawking, and inadequate road capacity.

Traffic Congestion Off-Hours

Table 3 provides insights into off-hour congestion, revealing that traffic persists beyond peak periods, particularly in commercial zones. Sabon Market records congestion from 9:00 a.m. to 11:59 a.m., 12:00–2:30 p.m., and again in the evening (5:00–5:30 p.m.), driven by market closing activities and the presence of long vehicles such as Dangote trucks and oil tankers. Mayfair and OAUTHC also experience sustained congestion during mid-day,

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reflecting overlapping institutional and commercial activities.

The identification of alternative routes such as Ife Polytechnic, Eleyele, Onireke/Rd7, and Oranfe demonstrates the potential of geospatial analysis in mitigating congestion. These findings emphasize that congestion in Ile-Ife is not limited to peak hours but is a continuous challenge shaped by socio-economic functions of each corridor. This resonates with Ukpata and Etika's (2012) study, which noted that unregulated parking and narrow roads exacerbate delays across Nigerian cities

Modal Distribution and Weekly Variation

Table 4 presents manual traffic counts in Mayfair business area, showing that motorcycles (okadas) consistently dominate traffic flow, with counts ranging from 98 in the afternoon to 171 in Friday morning peaks. This underscores the reliance on informal transport systems in Ile-Ife, which provide affordability and maneuverability but contribute significantly to congestion through lane indiscipline and unsafe practices (Ajayi, 2013).

Private and commercial cars also account for substantial shares, particularly in evening periods, reflecting commuter return trips and business closures. Trucks, though fewer in number, exacerbate congestion due to their size and slow maneuverability, consistent with Oladejo's (2024) observation that poor road infrastructure and driver behavior are critical causes of congestion. Weekly variation highlights Thursday and Friday as peak congestion days, with total counts exceeding 300 vehicles in some sessions. This mirrors socio-economic rhythms, where market activities and institutional schedules intensify traffic demand (Ajayi *et al*., 2017).

Figure 8 illustrates weekly traffic counts at Sabon-Oja market, showing sharp spikes mid-week (Wednesday and Thursday) when trading activities peak. The weekend decline reflects reduced institutional and market activities, though evening congestion persists due to social and recreational movements.

The dominance of motorcycles and tricycles in weekly traffic trends underscores the informal sector's role in shaping mobility. While these modes provide essential accessibility, their unregulated operations contribute to unsafe practices and congestion. This finding supports Oladejo's (2024) argument that poor road infrastructure and driver behavior are critical causes of congestion in Nigerian cities. Comparatively, Lagos exhibits similar mid-week peaks, though its larger scale and presence of mass transit options differentiate its traffic dynamics (Pucher, 2007).

Table 2: Traffic Congestion Peak Hours in Mayfare, Lagere, Sabon and OAUTHC
Source:(Researchers, 2025)

Location	Latitude	Longitude	Direction	Morning	Afternoon	Evening
Mayfare	7.489	4.534	Mayfare to Lagere			5:00pm-6:45pm
Lagere	7.4887	4.547	Lagere to Mayfare	8:00am- 8:45am		4:30pm-5:10pm
Sabon Market	7.49	4.553	Sabon to Opa		3:30pm-3:45pm	6:00p-6:30pm
OAUTHC	7.504	4.572	Ikoyi to OAUTHC	8:00am-8:45am		4:45pm-5:20pm

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Table 3: Traffic Congestion Off Hours in Mayfare, Lagere, Sabon and OAUTHC

Location	Latitude	Longitude	Morning	Afternoon	Evening	Alternative route(km)	Traffic volume	Causes
Mayfare	7.489	4.534	8:00am-11:59am	12:00pm-3:30pm		Ife polytechnic	127	Closing hours
Lagere	7.4887	4.547	10:00am-11:30am		6:00pm-7:00pm	Eleyele	135	Construction
Sabon Market	7.49	4.553	9:00am-11:59	12:00pm-2;30pm	5:00pm-5:30pm	Onireke/Rd7	167	Market closing/long vehicle
OAUTHC	7.504	4.572	9:00am-11:59	12:00pm-4:00pm		Oranfe	146	Office/School hours

Source:(Researchers, 2025)

Table 4: Manual Counting Traffic Congestion in Mayfare Business area

Day	Durationand Time	Car private	Car commercial	Tricycle	Motor cycle	Truck	Total
Monday	Morning	69	56	9	131	7	272
	Afternoo	71	57	8	98	6	240
	Evening	82	84	6	132	7	311
Tuesday	Morning	65	69	5	143	8	290
	Afternoo	75	61	9	122	5	272
	Evening	67	53	7	112	7	246
Wednesday	Morning	87	64	8	117	5	281
	Afternoo	75	71	10	132	9	297
	Evening	69	48	11	143	10	281
Thursday	Morning	68	70	6	153	5	302
	Afternoo	81	84	7	124	7	303
	Evening	71	76	8	131	6	292
Friday	Morning	65	43	5	171	5	289
	Afternoo	87	81	6	131	4	309
	Evening	45	70	8	121	6	250

Source:(Researchers, 2025)

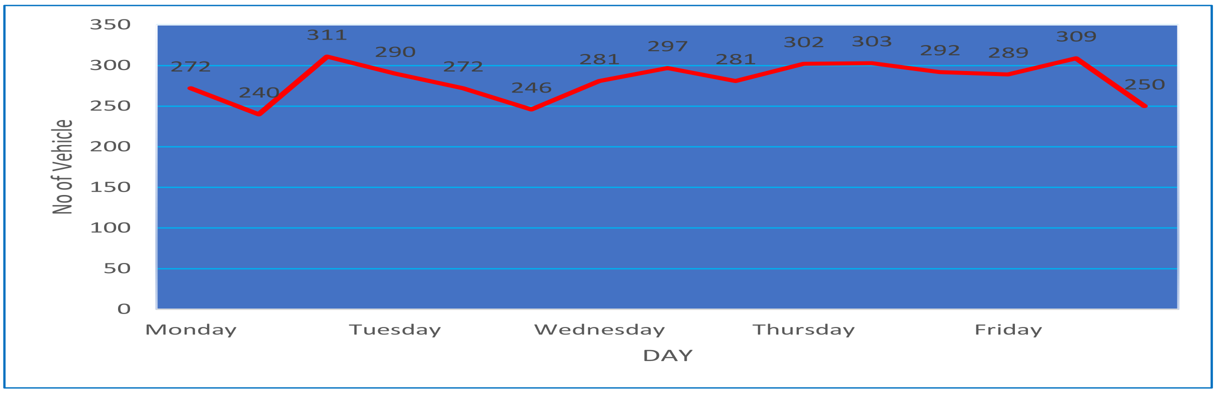

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Figure 8: Weekly Manual count of Traffic Congestion in Sabon-Oja market area, Ile-Ife

Source:(Researchers 2025)

Traffic Composition by Vehicle Type

Table 5 presents traffic composition across different times of the day, showing a clear dominance of motorcycles (okadas) and commercial cars during morning and evening peaks. For instance, Monday morning recorded 131 motorcycles compared to 69 private cars and 56 commercial cars. This reflects the affordability and maneuverability of informal transport modes, which remain the backbone of urban mobility in Ile-Ife (Ajayi, 2013). The evening periods consistently show higher totals, such as 311 vehicles on Monday evening, indicating commuter return trips and intensified market closures. Trucks, though fewer in number, contribute disproportionately to congestion due to their slow maneuverability and large size, consistent with Ukpata and Etika's (2012) findings on heavy vehicles worsening delays in Nigerian cities. Weekly variation shows Thursday and Friday as peak days, with totals exceeding 300 vehicles, mirroring socio-economic rhythms tied.

Figure 9 illustrates traffic density across major corridors, highlighting hotspots such as Mayfair, Lagere, and Sabon Market. The visualization confirms that congestion is concentrated in commercial and institutional zones, where road capacity is insufficient to handle peak-hour demand. This supports Pucher's (2007) argument that rapid urbanization without corresponding infrastructure investment leads to severe congestion in developing countriesto market activities and institutional schedules (Ajayi *et al.*, 2017).

Table 5: Manual Counting Traffic Congestion in Lagere banking area

Day	Durationand Time	Car private	Car commercial	Tricycle	Motor cycle	Truck	Total
Monday	Morning	69	56	9	131	7	272
	Afternoo	71	57	8	98	6	240
	Evening	82	84	6	132	7	311
Tuesday	Morning	65	69	5	143	8	290
	Afternoo	75	61	9	122	5	272
	Evening	67	53	7	112	7	246
Wednesday	Morning	87	64	8	117	5	281
	Afternoo	75	71	10	132	9	297
	Evening	69	48	11	143	10	281
Thursday	Morning	68	70	6	153	5	302
	Afternoo	81	84	7	124	7	303
	Evening	71	76	8	131	6	292
Friday	Morning	65	43	5	171	5	289
	Afternoo	87	81	6	131	4	309
	Evening	45	70	8	121	6	250

Source:(Researchers 2025)

DOI: https://doi.org/10.5281/zenodo.20541959

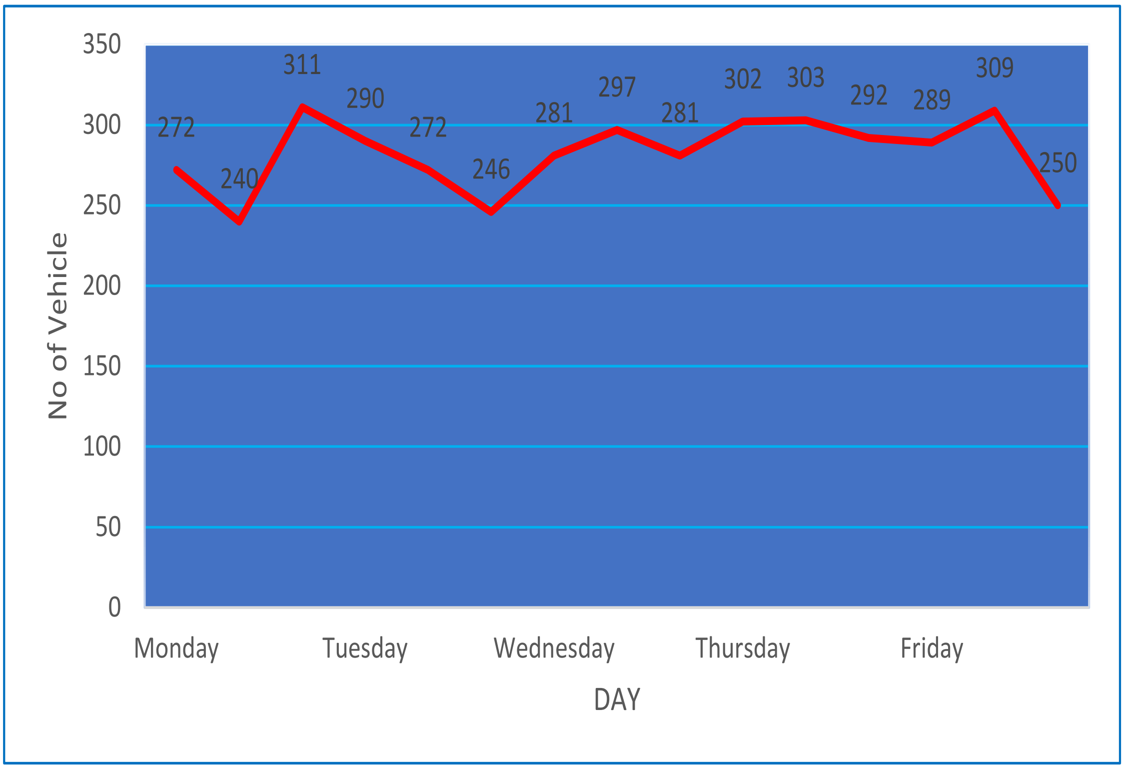

Figure 9: Weekly Manual count of Traffic Congestion in Lagere Banking Area, Ile-Ife
Source: :(Researchers 2025)

Table 6 highlights traffic flow distribution across selected corridors, revealing that commercial hubs such as Sabon Market and Lagere consistently record higher traffic volumes compared to residential or institutional zones. The data indicates that congestion is not only a function of vehicle numbers but also of road capacity and socio-economic activity. For example, Sabon Market's traffic volume surpasses 160 vehicles during peak hours, driven by trading activities and the presence of long vehicles such as Dangote trucks. This aligns with Adewuyi's (2019) study in Ibadan, which identified roadside hawking, inadequate parking, and heavy vehicles as critical congestion drivers.

The findings emphasize that traffic management strategies must prioritize commercial corridors, where informal activities and inadequate infrastructure exacerbate congestion.

Figure 10 maps alternative routes identified through geospatial analysis, such as Eleyele, Oranfe, and Ife Polytechnic corridors. These routes provide potential relief during peak congestion periods, particularly in areas affected by construction or market closures. The use of GIS-based network analysis demonstrates the value of spatial tools in optimizing traffic flow and reducing delays. This aligns with Olojede (2024), who emphasized the importance of geospatial techniques in traffic management and sustainable urban mobility.

Table 6: Manual Counting Traffic Congestion in Sabon-Oja Market area

DOI: https://doi.org/10.5281/zenodo.20541959

Day	Durationand Time	Car private	Car commercial	Tricycle	Motor cycle	Truck	Total
Monday	Morning	69	56	9	131	7	272
	Afternoo	71	57	8	98	6	240
	Evening	82	84	6	132	7	311
Tuesday	Morning	65	69	5	143	8	290
	Afternoo	75	61	9	122	5	272
	Evening	67	53	7	112	7	246
Wednesday	Morning	87	64	8	117	5	281
	Afternoo	75	71	10	132	9	297
	Evening	69	48	11	143	10	281
Thursday	Morning	68	70	6	153	5	302
	Afternoo	81	84	7	124	7	303
	Evening	71	76	8	131	6	292
Friday	Morning	65	43	5	171	5	289
	Afternoo	87	81	6	131	4	309
	Evening	45	70	8	121	6	250

Source: (Researchers 2025)

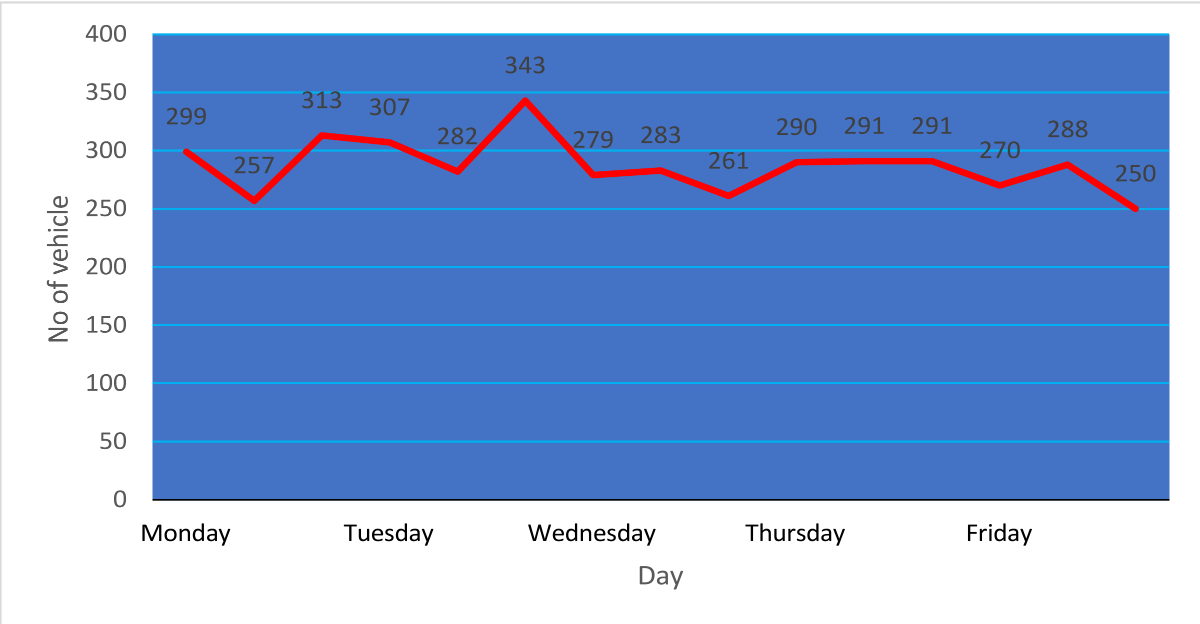

Figure 10: Weekly Manual count of Traffic Congestion in Sabon-Oja market area, Ile-Ife
Source: (Researchers 2025)

Table 7 provides insights into traffic delay times and underlying causes. The data shows that delays are most pronounced during morning and evening peaks, with average waiting times exceeding 20 minutes in some corridors. Causes include construction activities at Lagere, market closures at Sabon, and overlapping office/school schedules at OAUTHC. These findings underscore the multi-dimensional nature of congestion in Ile-Ife, where physical infrastructure limitations intersect with socio-economic activities.

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Oladejo (2024) emphasizes that poor road infrastructure and driver behavior are critical causes of congestion in Nigerian cities, and this study confirms that these factors are equally relevant in Ile-Ife's context.

Figure 11 presents weekly traffic trends, showing sharp spikes mid-week (Wednesday and Thursday) and declines during weekends. The mid-week peaks coincide with intensified trading activities and institutional schedules, while weekend declines reflect reduced formal activities. However, evening congestion persists due to social and recreational movements.

The visualization reinforces the findings from Tables 5–7, highlighting the dominance of motorcycles and tricycles in weekly traffic patterns. While these modes provide essential accessibility, their unregulated operations contribute to unsafe practices and congestion. This finding supports Oladejo's (2024) argument that driver behavior and poor infrastructure are critical causes of congestion in Nigerian cities.

Table7: Manual Counting Traffic Congestion in Obafemi Awolowo UniversityTeaching Hospital Ile-Ife

Day	Durationand Time	Car private	Car commercial	Tricycle	Motor cycle	Truck	Total
Monday	Morning	87	65	14	127	5	298
	Afternoo	67	45	4	130	8	254
	Evening	79	80	7	142	4	312
Tuesday	Morning	54	75	9	160	9	307
	Afternoo	81	54	10	132	7	284
	Evening	71	45	5	124	5	250
Wednesday	Morning	92	59	11	131	6	299
	Afternoo	74	67	6	129	10	286
	Evening	71	54	7	112	8	252
Thursday	Morning	65	72	4	121	7	269
	Afternoo	74	82	11	132	5	304
	Evening	66	73	9	122	4	274
Friday	Morning	54	67	6	110	8	245
	Afternoo	49	76	5	121	6	257
	Evening	51	69	7	108	5	240

Source: (Researchers 2025)

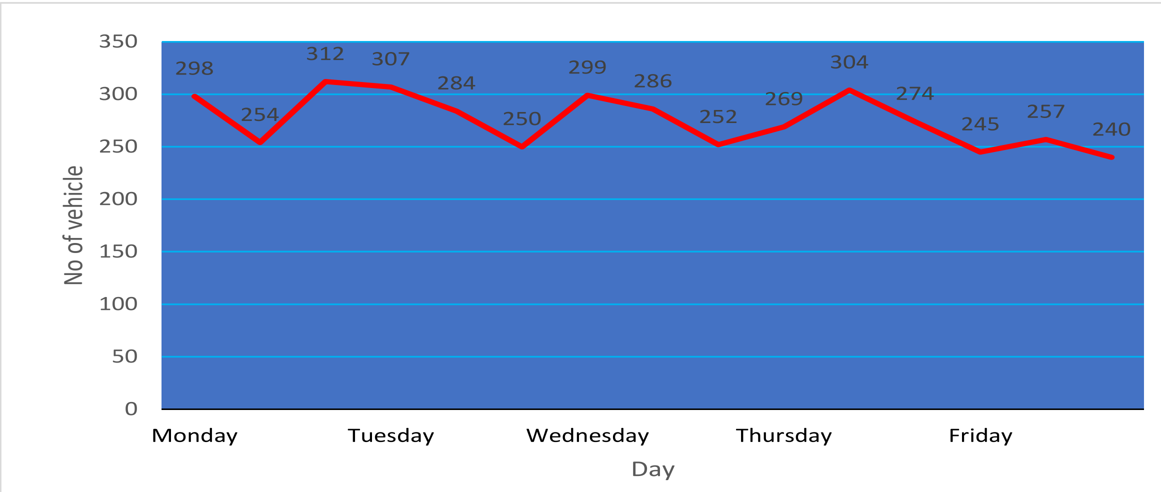

Figure 11: Weekly Manual count of Traffic Congestion in Obafemi Awolowo University

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Teaching Hospital, Ile-Ife Source: (Researchers 2025)

To identify alternative routes to reduce congestion and improve accessibility in the study

Table 8 provides detailed insights into traffic delay times across selected corridors in Ile-Ife. The data shows that average delays range between 15–25 minutes during peak hours, with the longest delays recorded at Sabon Market and Lagere. These delays are primarily caused by overlapping socio-economic activities, inadequate parking, and the presence of heavy vehicles. For instance, Sabon Market records delays exceeding 20 minutes during evening hours due to market closures and long vehicles occupying narrow roadways. This finding aligns with Ajayi (2017) study in Ibadan, which identified roadside hawking, double parking, and inadequate road capacity as critical contributors to traffic delays. The implication is that congestion in Ile-Ife is not only a function of traffic volume but also of road use behavior and infrastructure limitations, underscoring the need for targeted interventions such as regulated parking and improved traffic control.

Figure 12 visualizes traffic density hotspots across the metropolis, highlighting Mayfair, Lagere, and Sabon Market as the most congested zones. These hotspots correspond with areas of intense commercial and institutional activity, where road capacity is insufficient to handle peak-hour demand. The visualization confirms that congestion is concentrated in economic and academic corridors, supporting Pucher's (2007) argument that rapid urbanization without corresponding infrastructure investment leads to severe congestion in developing cities. Figure 13 illustrates alternative routes identified through geospatial analysis, such as Eleyele, Oranfe, and Ife Polytechnic corridors. These routes provide potential relief during peak congestion periods, particularly in areas affected by construction or market closures. The use of GIS-based network analysis demonstrates the value of spatial tools in optimizing traffic flow and reducing delays. This aligns with Olojede (2024), who emphasized the importance of geospatial techniques in traffic management and sustainable urban mobility.

Figure 14 presents traffic flow visualization across major corridors, showing directional patterns of congestion. For example, traffic from Mayfair to Lagere intensifies during evening hours, while flows towards OAUTHC peak in the morning due to overlapping office and school schedules. This visualization highlights the temporal and directional nature of congestion, confirming that traffic management strategies must be location-specific and time-sensitive. Similar directional congestion patterns have been observed in Lagos and Ibadan, where institutional and commercial activities dictate traffic flows (Ajayi *et al*., 2017).

Figure 15 illustrates weekly traffic trends, showing sharp spikes mid-week (Wednesday and Thursday) and declines during weekends. The mid-week peaks coincide with intensified trading activities and institutional schedules, while weekend declines reflect reduced formal activities. However, evening congestion persists due to social and recreational movements. The visualization reinforces the findings from Table 8 and Figures 12–14, highlighting the dominance of motorcycles and tricycles in weekly traffic patterns. While these modes provide essential accessibility, their unregulated operations contribute to unsafe practices and congestion. This finding supports Oladejo's (2024) argument that driver behavior and poor infrastructure are critical causes of congestion in Nigerian cities.

Table 8: Alternative route to traffic congestion of the study area

S/N	Location	Direction	Route	Alternative route	Time	Alternative Time
1	Mayfare	Hilton-Ife poly	0.9km	2.3km	4minutes	10minutes
2	Lagere	Eleyele -Olabisi	1.2km	1.4km	3minute	8minute
3	Sabon market	Onirike Ilare rd7	0.7km	1.2km	2minute	5minute
4	OAUTHC	Oroki Oranfe	0.4KM	0.6KM	2minute	4minute

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Source: (Researchers 2025)

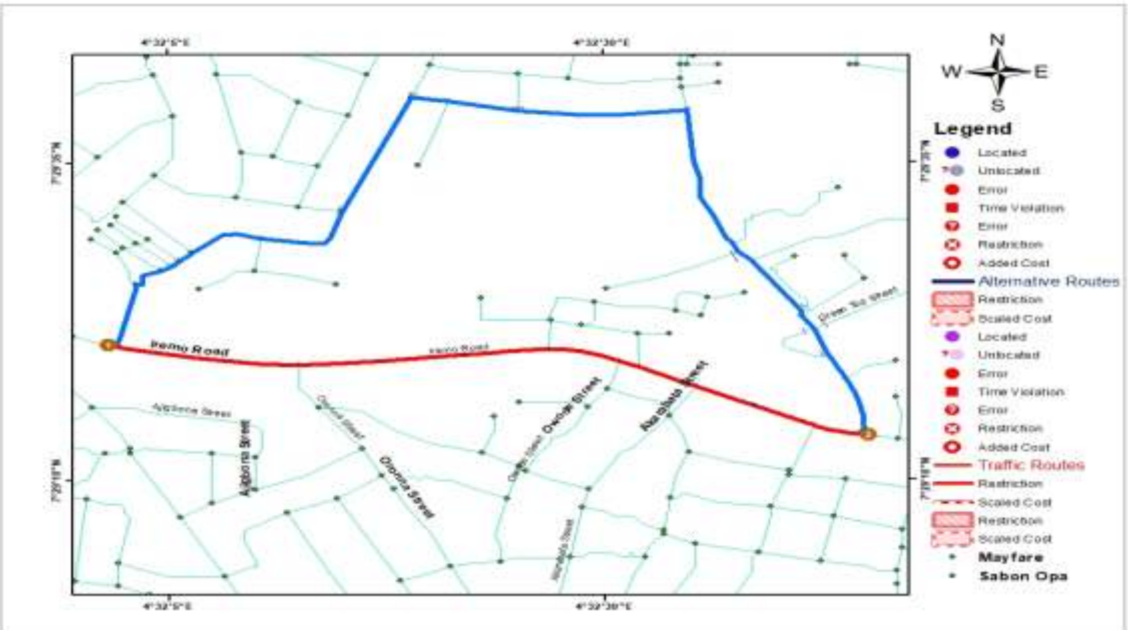

Figure 12: Alternative Route for Traffic Congestion in MayFare Business area of Ile-Ife Source: (Researchers 2025)

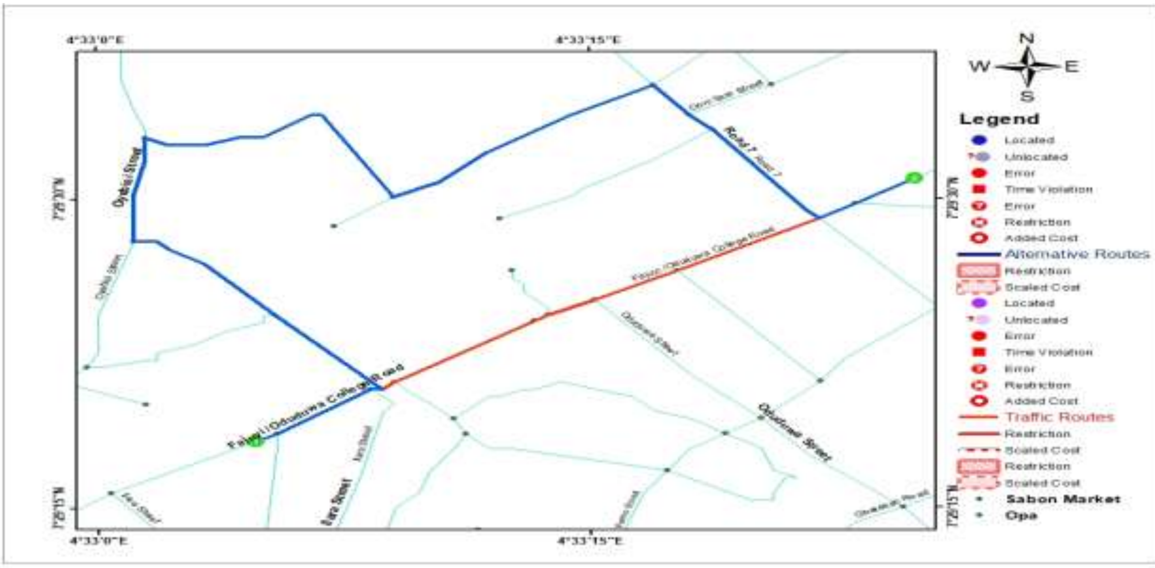

Figure 13: Alternative Route for Traffic Congestion in Lagere Banking area of Ile-Ife Source: (Researchers 2025)

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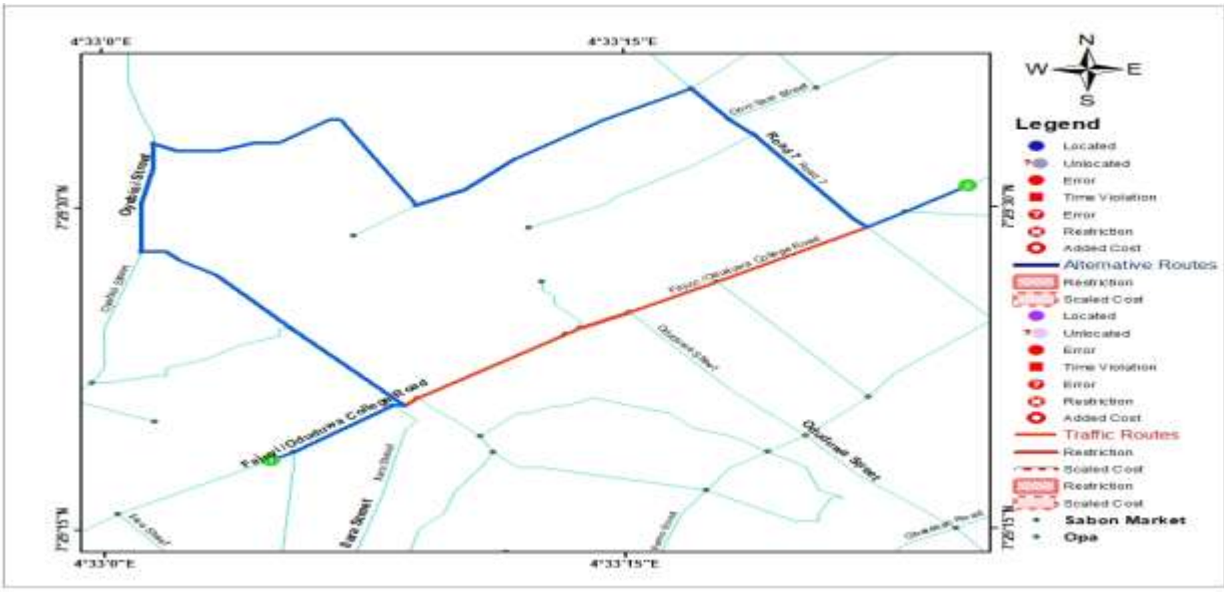

Figure 14: Alternative Route for Traffic Congestion in Sabo-Oja area of Ile-Ife
Source: (Researchers 2025)

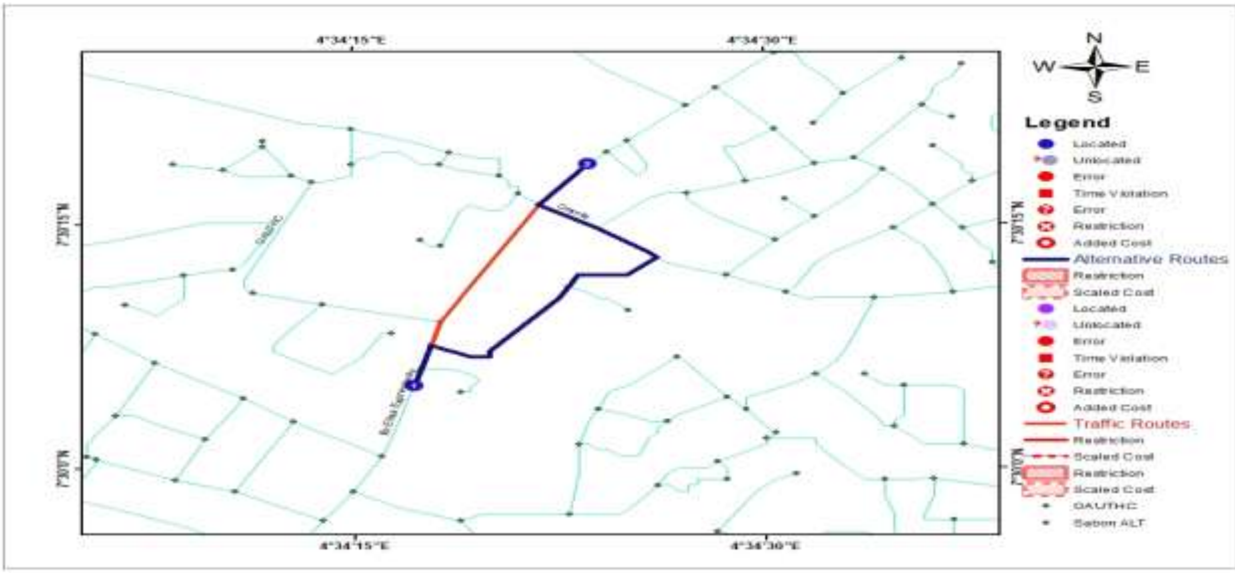

Figure 15: Alternative Route for Traffic Congestion Obafemi Awolowo University Teaching Hospital of area of Ile-Ife
Source: (Researchers 2025)

Conclusion

This study has shown that traffic congestion in Ile-Ife metropolis is multi-dimensional, shaped by peak-hour demand, off-hour commercial activities, modal distribution, and socio-economic rhythms. Using geospatial techniques, critical junctions and density hotspots were mapped, revealing that congestion is concentrated in commercial and institutional corridors such as Mayfair, Lagere, Sabon Market, and OAUTHC. Motorcycles and tricycles dominate traffic flows, while heavy vehicles exacerbate delays in narrow corridors. Weekly traffic trends highlight mid-week peaks driven by market and institutional activities, with off-hour congestion persisting due to overlapping socio-economic functions.

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Despite these contributions, the study is limited by its reliance on manual traffic counts conducted over a short observation period, which may not fully capture seasonal variations or long-term traffic dynamics. Additionally, informal transport systems were assessed primarily through volume counts, without deeper behavioral analysis of driver practices. Future research should incorporate longer-term datasets, automated traffic sensors, and behavioral studies to provide more robust insights.

Based on the findings, recommendations include stricter regulation of informal transport operations, expansion and maintenance of road infrastructure, provision of designated parking spaces, and adoption of GIS-based traffic management systems. Integrating geospatial analysis into policy frameworks will enable more efficient planning, improve accessibility, and promote sustainable urban mobility in Ile-Ife and similar developing cities.

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