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ANALYSIS OF URBAN TRAFFIC COMPOSITION AND CONGESTION USING CLASSIFIED TRAFFIC COUNT DATA: A STUDY OF ITA - MARUN AXIS, EPE, LAGOS STATE, NIGERIA

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Abstract
Urban traffic congestion remains a major challenge in rapidly growing cities, particularly in Lagos State, Nigeria, where increasing population and economic activities continue to place pressure on existing road infrastructure. This study examines urban traffic congestion using classified traffic count data collected along the Ita Marun axis in Lagos State. The objective is to analyse traffic composition, variation in traffic flow, and peak congestion periods within the study area. Primary data on classified vehicles were obtained through manual traffic counts conducted at hourly intervals from 8:00 a.m. to 7:00 p.m., and the data were analysed using descriptive statistical tools including frequencies, percentages, mean, and standard deviation. The results reveal that tricycles, cars, and motorcycles dominate traffic flow along the corridor, while heavy-duty vehicles such as tankers and trailers are minimally present. The findings further show significant variation in traffic volume across different time periods, with clear peak congestion periods observed during the day. The study concludes that traffic flow along the Ita Marun axis is highly unstable and largely influenced by para-transit and private vehicles. The study recommends improved traffic management strategies and transport planning interventions to reduce congestion and enhance mobility efficiency along the corridor.

Keywords: *Classified Traffic Count, Data, Traffic Congestion, Urban Transportation, Urban Mobility*

Introduction

Urban traffic congestion has become a major challenge confronting cities across the world, particularly in developing countries where rapid urbanisation has outpaced the provision of transportation infrastructure. As cities expand and economic activity increases, transportation networks often face demand beyond their designed capacity. The consequences include longer travel times, increased fuel consumption, environmental degradation, road deterioration, and reduced economic productivity. Lagos State represents one of the fastest-growing urban centres in Africa

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and serves as Nigeria's commercial and economic hub. Continuous population growth, commercial activity, housing development, and transportation demand have intensified pressure on the state's road network.

According to Aigbe *et al.* (2012), the condition of many roads in Lagos is characterised by inadequate infrastructure provision and poor maintenance, factors that significantly affect mobility and contribute to traffic delays. Similarly, Obiorah *et al.* (2025) argue that inadequate infrastructure remains one of the major impediments to sustainable development in Nigeria, emphasising the need for increased investment in transportation facilities. The challenge has been further compounded by rapid urban expansion across different parts of Lagos. Oyalowo (2022) observed that urban growth has extended beyond traditional planning boundaries, creating complex transportation and land-use challenges.

In the Lekki-Epe corridor, Muniru *et al*. (2024) identified significant variations in transit-oriented development potential, revealing that areas with greater economic activities and land-use integration tend to attract higher transportation demand. Such developments inevitably generate increased vehicular movement and place additional pressure on existing road networks. Several studies have highlighted the relationship between traffic composition and congestion. Atomode (2017) found that passenger vehicles account for approximately 92 percent of total vehicular traffic in Lagos, while freight vehicles account for about 8 percent. Although freight vehicles constitute a relatively smaller proportion of total traffic, the study emphasised their critical role in supporting urban economic activities. The findings further revealed substantial variations in freight traffic across different locations, particularly in major economic corridors such as Apapa and Epe. Likewise, Nwoye and Iyiola (2016) reported that major corridors within Lagos had exceeded their designed carrying capacities, resulting in severe congestion and accelerated road deterioration. Their study also showed that traffic composition differs across corridors, with heavy-duty vehicles contributing significantly to road overload in some locations.

The increasing level of congestion has generated interest in alternative transportation and traffic management solutions. Chilaka and Uluocha (2023) highlighted the economic importance of Lagos' lagoon system and emphasised the need to harness water transportation as a means of reducing pressure on road transport infrastructure. In the same vein, Adamu *et al.* (2023) examined congestion pricing as a traffic management strategy and found that road users expressed concerns regarding the effectiveness and fairness of tolling systems. Their findings suggest that while congestion management policies are necessary, successful implementation depends on public acceptance and supporting institutional frameworks.

Technological innovations have also emerged as potential solutions to urban traffic problems. Ilesanmi (2025) demonstrated that smart traffic light systems could improve traffic flow efficiency and reduce vehicular emissions in major Lagos traffic corridors. Similarly, Aderibigbe *et al.* (2025) reported that digital twin-driven transportation systems could significantly reduce congestion levels, improve travel times, and enhance operational efficiency through real-time monitoring and predictive maintenance.

These findings indicate that technology can play a significant role in improving urban mobility when supported by reliable traffic data and effective transportation planning. Infrastructure financing and governance have equally attracted scholarly attention.

One of the arrangements to encourage technology-driven transport is through public-private partnerships, through the provision of infrastructure towards improving urban mobility and general road transport infrastructure development (Nwangwu, 2021). However, Yissa (2024) noted that political, legal, financial, and institutional constraints often undermine the effectiveness of such partnerships. Supporting this argument, Asogwa *et al.* (2025) emphasised the importance of strategic infrastructure investment and public-private collaboration in improving transportation facilities and enhancing economic development. Studies have also examined congestion from the perspective of freight movement and port activities. Olayiwola *et al.* (2026) found a significant relationship between intermodal transportation factors and congestion around the Lekki Deep Sea Port, concluding that effective cargo movement requires better integration of transportation modes. Furthermore, Ltman (2018) stressed the importance of prioritising road infrastructure investments in locations with high transportation demand to improve mobility and reduce congestion pressures.

Despite the growing body of literature on transportation and congestion in Lagos, existing studies have largely focused on major expressways, seaport corridors, infrastructure financing, congestion pricing, smart mobility systems, and regional transportation planning. Comparatively little attention has been given to localised traffic conditions on inner urban corridors using detailed classified traffic count data. This creates a gap in understanding the traffic characteristics of many urban roads that play important roles in daily mobility and economic activities.

Urban Traffic Congestion and Deficit in Transportation Infrastructure

Traffic congestion poses considerable economic challenges, as it can adversely affect businesses and render a city less attractive Naveed *et al.,* (2024). Urban traffic congestion is a growing concern in many developing cities due to increasing population, rapid urbanisation, and inadequate transportation infrastructure. In Lagos State, traffic congestion has become a persistent challenge affecting mobility, economic productivity, and environmental sustainability. Aigbe *et al.* (2012) observed that the provision and maintenance of road infrastructure in Lagos remain inadequate, resulting in poor road conditions and reduced transport efficiency. Similarly, Obiorah *et al.* (2025) argued that Nigeria's infrastructure deficit continues to constrain development outcomes, emphasising the need for sustained investments in transportation facilities. The problem is further aggravated by the rapid expansion of urban settlements.

Oyalowo (2022) noted that urban growth in Lagos has created significant planning and transportation challenges, while Muniru *et al.* (2024) identified areas of intense development along the Lekki-Epe corridor that are likely to generate increased travel demand. These findings suggest that infrastructure development has not kept pace with urban growth, thereby contributing to congestion across major and minor road corridors. The carrying capacity of roads also plays an

important role in congestion levels. Nwoye and Iyiola (2016) found that major corridors in Lagos had exceeded their designed carrying capacities, resulting in traffic delays and accelerated road deterioration. Their findings indicate that increasing traffic volumes continue to place significant pressure on existing road infrastructure.

Traffic Composition and Congestion Dynamics

Traffic composition is a key determinant of traffic flow and congestion. Different vehicle categories occupy road space differently and influence traffic movement in various ways. Atomode (2017) found that passenger vehicles account for the majority of vehicular traffic in Lagos State, representing approximately 92 percent of total traffic volume, while freight vehicles account for only 8 percent. Despite their smaller share, freight vehicles remain essential for urban economic activities and can significantly affect traffic conditions in areas with high commercial activities. Studies focusing on freight transportation have also highlighted the impact of economic activities on road congestion. Olayiwola *et al.* (2026) found a significant relationship between port-related activities and congestion around the Lekki Deep Sea Port (LDSP), emphasising the importance of effective intermodal transportation systems for cargo movement. Likewise, Chilaka and Uluocha (2023) emphasised the need to harness water transportation as an alternative mode of transport capable of reducing pressure on road networks in Lagos. Traffic management policies have also been examined as tools for congestion reduction. Adamu *et al.* (2023) investigated congestion pricing in Lagos and found that most road users opposed the reintroduction of toll gates, citing concerns about fairness and policy effectiveness. The study further revealed that challenges associated with electronic tolling could affect its ability to address congestion effectively.

Technological and Institutional Approaches to Congestion Management

Recent studies have increasingly focused on technology-driven solutions for improving urban mobility. Ilesanmi (2025) demonstrated that smart traffic light systems have the potential to improve traffic flow efficiency and reduce congestion in major Lagos corridors. Similarly, Aderibigbe *et al.* (2025) reported that digital twin technology can enhance transportation management by reducing vehicle downtime, improving travel times, and supporting real-time decision-making. Beyond technology, institutional and financial arrangements have also been identified as important factors in transportation development.

The development of transport is tied to its infrastructure, which can be broadly categorised under the following headings: roads, ports, harbours, airports, bridges and tunnels, rail, trams, waterways, bike paths, walkways and pipeline networks (Taylor, 2021). However, Yissa (2024) found that political, legal, and financial constraints often undermine the effectiveness of such arrangements. Supporting this position, Asogwa *et al.* (2025) emphasised the importance of strategic infrastructure financing in revitalising transportation facilities and promoting economic development. Litman, (2018) further stressed the need for prioritising transportation projects based on their potential impact on mobility and accessibility. Also, despite extensive policy support for public-private partnerships in the transport sector,

it is concerning that the PPP is yet to gain traction (Qazeem, 2021). Their study demonstrated that systematic infrastructure planning can contribute significantly to improved transportation performance and congestion reduction. These studies and several more on transportation and congestion in Lagos have largely concentrated on major corridors, seaport activities, infrastructure financing, smart mobility systems, and transportation planning. However, limited attention has been given to localised urban corridors using classified traffic count data. Specifically, empirical evidence on traffic composition, hourly traffic variation, and congestion patterns along the Ita Marun axis remains scarce.

This study seeks to fill this gap by providing a detailed analysis of urban traffic congestion using classified traffic count data from the study area. In light of the foregoing, this study examines urban traffic congestion using classified traffic count data on the Ita Marun axis of Lagos State. Specifically, the study analyses traffic composition, traffic volume distribution, and peak traffic periods to provide a clearer understanding of congestion patterns within the study area. The findings are expected to contribute to transportation planning efforts and provide useful information for traffic management and infrastructure improvement initiatives in Lagos State.

Study Area

The study area, Ita-Marun, is situated in Epe LGA, Lagos State, as shown in Fig. 1. It is considered one of the important transport hubs in the Local Government, with high fluidity of traffic at the selected location, which has a significant impact on the economy due to its interconnectivity with other communities and seamless movement of people, goods and services. Epe is located at coordinates 6° 35′N 3° 59′E in the northern part of Lekki Lagoon (Tchounwou *et al.,* 2012). It has a surface area of more than 243km^2 and is sandwiched between two other lagoons, the Lekki Lagoon (freshwater) in the east and Lagos Lagoon (brackish water) in the west. The lagoon is connected to the sea through the Lagos Harbour (Adebanjo *et al.,* 2020).

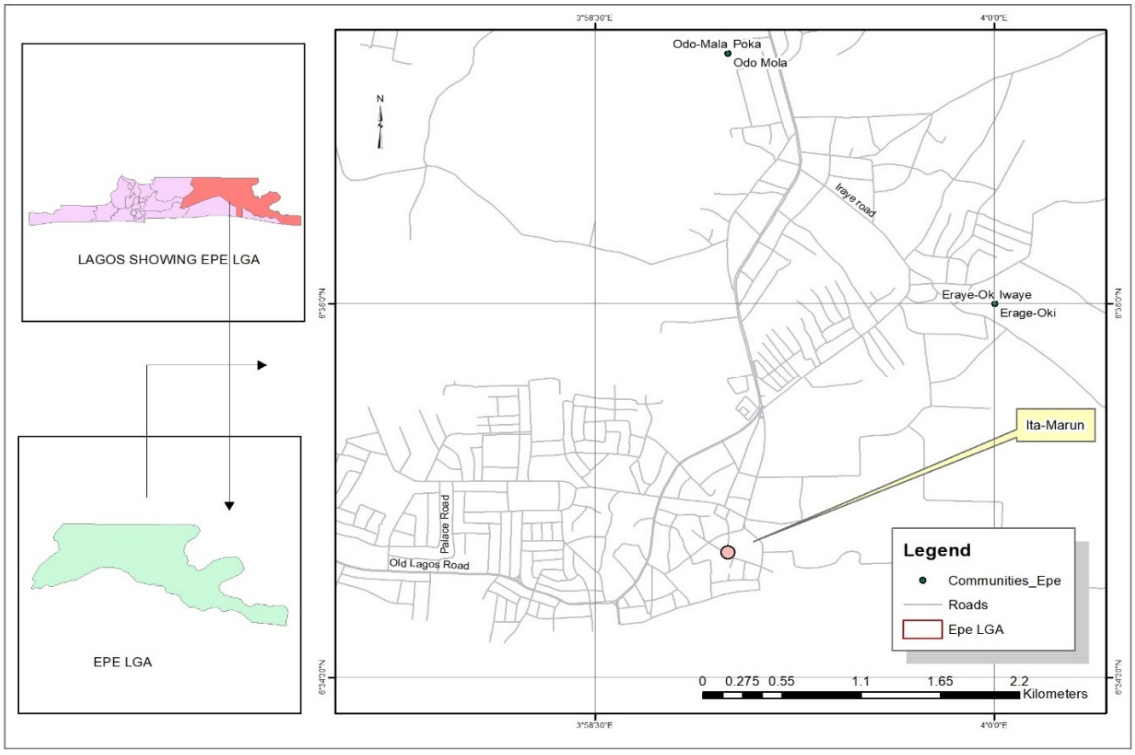


Fig. 1. Study Area

Method

The study adopted a descriptive research design to examine the characteristics of traffic flow along the Ita Marun axis in Lagos State, Nigeria. This design was considered appropriate because it allows for the systematic observation and description of traffic patterns under real-life conditions without variable manipulation. Primary data were used for the study. The data were obtained from a classified traffic count conducted along the Ita - Marun axis. Vehicles passing the selected observation point were manually counted and recorded at hourly intervals from 8:00 a.m. to 7:00 p.m. over a one-day observation period. The vehicles were grouped into categories, including motorcycles (Okada), tricycles (Keke Napep), cars, sport-utility vehicles (SUVs), minibuses, large buses, tankers, trailers, trucks/tippers, and bicycles. This classification enabled a detailed assessment of traffic composition along the corridor. In addition, hourly traffic counts were used to examine variations in traffic flow and identify peak and off-peak periods along the corridor.

Data Classification and Presentation

Table 1: Data and Vehicle classification in relation to time

TIME	OKADA	TRICYCLE/	CAR	SUV/JEEP	MINI-BUS	BIG-BUS	TANKER	TRAILER	TRUCK/TIF	BICYCLE	TOTAL
8-9am	200	580	201	10	16	9	0	4	53	0	1073
9-10am	197	450	105	40	30	15	15	7	55	0	914
10-11am	265	625	495	51	15	11	0	5	44	0	1511
11-12am	183	540	400	41	16	3	0	1	30	0	1214
12-1pm	111	215	317	49	11	0	1	0	28	0	732
1-2pm	215	350	199	70	1	1	0	0	10	0	846
2-3pm	193	394	187	25	12	7	2	0	0	0	820
3-4pm	205	285	90	10	7	9	0	0	0	0	606
4-5pm	312	257	97	21	17	15	0	0	0	0	719
5-6pm	211	315	280	15	13	10	0	1	9	0	854
6-7pm	191	414	83	30	27	15	0	1	20	0	781
TOTAL	2283	4425	2454	362	165	95	18	19	249	0	10070

Data Analysis

The data collected were analysed using simple descriptive statistics. Frequencies and percentages to determine the proportion of each vehicle type in relation to total traffic volume and to examine traffic characteristics along the Ita - Marun axis. The analysis focused on summarising and interpreting the classified traffic count data in terms of frequency, percentage distribution, mean values, and measures of variability. This approach was adopted to provide a clear understanding of traffic composition, flow patterns, and congestion levels within the study area. The results are presented in a simple, interpretable form to highlight variations in vehicular movement across time periods and to support meaningful conclusions about urban traffic congestion patterns.

Results

Hourly Traffic Composition and Volume Distribution

As a result of processing the observational data on Ita - Marun traffic volume distribution, it was observed that the traffic volume in a single direction ranges from a little above 700 to above 1500 vehicles hourly (Table 1), constituting 7.3- 15.0 per cent of vehicles per hour. The distribution of traffic volume (N_1) on the road is approximated by a linear equation (Orsini *et al*., 2020; Lyashuka *et al*., 2022). The linear equation seems valid when the traffic flow contains or falls within the range in terms of the percentage of the classified vehicles.

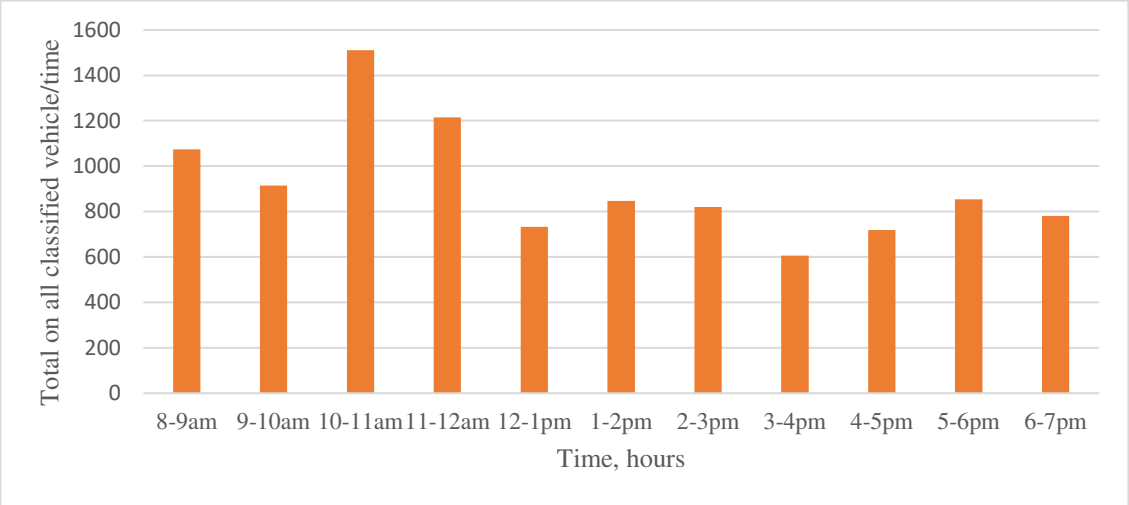


Fig. 2: Distribution of traffic volumes hourly on Ita -Marun corridor

Summary statistics are set out in Table 2, based on the values as indicated and the variations that are seen in the classification of vehicles.

Table 2: Summary Statistics

	Okada	**Tricycle**	**Car**	**SUV**	**Mini Bus**	**Big Bus**	**Tanker**	**Trailer**	**Truck /Tipper**
Mean	380.5	737.5	409.0	60.3	27.5	15.83	3.00	3.167	41.50
Median	202.5	404.0	200.0	35.0	15.5	9.50	0.00	1.000	24.00
Maximum	2283.0	4425.0	2454	362	165	95.0	18.00	19.00	249.00
Minimum	111.0	215.0	83.00	10.0	1.00	0.000	0.00	0.000	0.000
Std. Dev.	601.02	1168.40	657.1	96.7	43.9	25.466	6.368	5.508	68.33
Skewness	2.9814	2.9497	2.810	2.82	2.85	2.789	1.794	2.184	2.572
Kurtosis	9.9684	9.8529	9.3302	9.40	9.49	9.298	4.345	6.859	8.482
Jarque-Bera	42.0565	40.8824	35.83	36.5	37.3	35.39	7.342	16.99	28.256
Probability	0.0000	0.0000	0.000	0.00	0.00	0.0000	0.025	0.0002	0.0000
Sum	4566.00	8850.0	4908	724	330	190.0	36.00	38.00	498.00
Sum Sq. Dev.	3973415	15016731	4749052	102936.7	21289	7133.67	446.0	333.67	51369.0
Obs	12	12	12	12	12	12	12	12	12

The analysis of traffic data collected along the Ita Marun axis provides important insights into urban traffic congestion and vehicle movement patterns in the study area. The descriptive statistics show that tricycles (Keke Napep) recorded the highest average traffic volume, with a mean of 737.5, followed by cars at 409.0 and Okada at 380.5. This indicates that the corridor is largely dominated by para-transit and private vehicles, which are commonly used for short-distance movement within Lagos. In contrast, minibuses and big buses recorded relatively low mean values of 27.5 and 15.83, respectively, while heavy-duty vehicles such as tankers and trailers recorded very low averages of 3.00 and 3.167. This suggests that the Ita Marun axis is not a major freight corridor but rather a passenger-oriented urban route. The standard deviation values further reveal a high level of variation in traffic flow across all vehicle categories.

Tricycles, Cars, and Okada recorded particularly high standard deviations of 1168.4, 657.1, and 601.02, respectively, indicating significant fluctuations in traffic volume across different time periods. This instability reflects the presence of strong peak and off-peak traffic conditions, which is typical of urban corridors influenced by commuting and commercial activities. The maximum values recorded also show sharp increases in traffic volume at certain periods, with tricycles reaching as high as 4425, cars 2454, and Okada 2283, while some categories such as tankers and trailers recorded minimum values of zero, indicating that they are not consistently present throughout the day. The data distribution also shows that all vehicle categories are positively skewed, meaning traffic volumes are generally concentrated at lower values with occasional extreme peaks. This suggests that congestion on the corridor does not occur uniformly but instead happens at specific periods of the day. The kurtosis values are also relatively high for most categories, indicating a leptokurtic distribution where traffic flow is sharply peaked around certain periods rather than evenly distributed. This further confirms congestion spikes during peak hours. In addition, the test results show that all probability values are approximately zero, indicating that the traffic data is not normally distributed, and the test proved optimal asymptotic power and good finite sample properties (Jarque and Bera, 1987). This is expected in traffic studies because vehicle flow is influenced by human movement patterns, economic activities, and time-specific commuting behavior, all of which lead to irregular and unpredictable traffic patterns. Therefore, the findings reveal that the Ita - Marun axis is dominated by tricycles, cars, and motorcycles, which together account for the bulk of daily traffic volume. Traffic flow along the corridor is highly unstable and varies significantly across time, with clear peak congestion periods and relatively lower off-peak periods. Although heavy-duty vehicles are present in very small numbers, the dominance of para-transit vehicles contributes significantly to congestion levels. The highly skewed and non-normal nature of the data further confirms that traffic conditions on the corridor are dynamic and strongly time-dependent, reflecting real-life urban mobility challenges in Lagos State.

Discussion

On the whole, the study sought to analyse the traffic composition and congestion on the Ita–Marun axis of the Epe Local Government Area in Lagos State, Nigeria. The hourly difference in traffic count likely reflects the variations in traffic volume and distribution in the study area. This variation in traffic composition and volume distribution of the classified vehicles showcases the inadequacy of road maintenance (Aigbe *et al.,* 2012; Litman, 2018). This reduces the efficiency of transportation because it is not a major freight corridor. This view is corroborated by Obiorah *et al.* (2025). The tricycles, Cars, and Okada recorded maximum values in the traffic composition in the corridor. A plausible explanation for these maximum values of this class of vehicles is that this option of transport suits various roads and distances of travel within the corridor due to its affordability for going to work, markets, and schools, and coupled with the fact that they are passenger vehicles. According to Atomode (2017), it is believed that passenger vehicles account for the

majority of vehicle traffic in Lagos State, accounting for 92 percent of total traffic volume, while freight volume accounts for only 8 percent. This corresponds with a similar belief where 'the need to harness water transport was emphasised as an alternative mode of transportation which is capable of reducing road network pressure' (Chilaka and Uluocha, 2023).

On the other hand, the pattern of distribution of the data associate's vehicle categories is skewed, and there is a general concentration of lower values during the peak period, indicating that congestion isn't uniformly occurring except at some specific periods of the day, which may be caused by rapid urban expansion (Oyalowo, 2022), and being an area with great activities of the economy and integration of land use, which attracts high demand for transportation (Muniru *et al.,* 2024). The activities of the economy in the area happens to be the reason for the movement of people, goods and services, even though the goods movement from place of origin to that of destination to allow goods get to the consumer, this process can be cut short if there are no such movements of goods and to also push this further, the movement of goods are impossible without the effort of man, this is because roles are being played by man to move the goods, for instance the loading, transloading and offloading of goods is being done by man for seamless movement and safety to various destinations and the operation of the mode of transport (road – drivers) to move the goods are also being done by man, for instance, the driver that drives the car or a loco pilot for movement of goods using the rail.

Similarly, the focus on technological driven solution is a strategy to enhance urban mobility despite urban expansion. This technology-driven solution is a way of improving traffic flow efficiency and reducing congestion in the corridor (Ilesanmi, 2025). This is in tandem with Aderigbigbe *et al.* (2025). The essence of this is to basically make urban mobility seamless despite factors that can potentially impede this seamless flow.

Conclusion

This study makes a unique contribution to the growing body of knowledge on traffic composition and distribution in Lagos State, Nigeria. Its specific contribution is the Analysis of traffic volume, composition and distribution in the study area. It can be easily concluded that the dominant classes of vehicles on that corridor are tricycles, cars and motorcycles. The major limitation to the study is the manual nature of data collection of the classes of vehicles counted in the study area. This is because the manual counts are being done by humans, and they may get tired, while the automatic count can run as long as it can, and it provides deeper metrics, such as the speed of vehicles and vehicle length, which are useful variables to measure in traffic volume studies. In light of the above, to carry out similar studies to enhance transport planning, a technology-driven solution for data collection is required for deeper metrics; government partnership with transportation stakeholders should be paramount; adequate financing should be put in place to purchase and install technology-driven equipment like traffic signal lights for seamless flow of traffic and avoidance of traffic congestion; formulation and implementation of policies to solve traffic volume and congestion problems.

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