ROAD TRAFFIC CONGESTION ANALYSIS AT OLOKO-IRESE-AGBOGBO JUNCTIONS ON ILESA-BENIN HIGHWAY AKURE ONDO STATE NIGERIA

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UNIVERSITI SAINS MALAYSIA

2024

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by

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Thesis submitted in fulfillment of the requirements
for the degree of
Doctor of Philosophy

June 2024

ACKNOWLEDGEMENT

I cannot express enough thanks to my God. First and foremost, I give glory to the almighty God for His wonderful grace upon my life. My heartfelt appreciation goes to my Supervisor, Dr. Diana Mohamad, who supervised my Ph.D. work and gave me strong encouragement, learning opportunities, support, and motivation at the most challenging moments of this academic program. May God continue to increase His glory upon your life, ma (thank you, my mummy). Also, I must deeply appreciate the support from my co-supervisors, Assoc. Prof. Dr. Nurwati Badarulzaman and Mr. Abdul Ghapar Othman for their individual contributions. Thanks to my parents, (Rtd) Sgt Rasheed Ogunyemi and Mrs Oluwayemisi Ogunyemi, and my siblings for their continued supportive prayers. My deepest gratitude to my supportive wife, Omobola Ogunyemi (MSc, ACA, BSc). Her encouragement when the times got rough and tough, for providing the web of peace and emotional balance I needed, and the countless times she kept the children during my hectic schedules will not be forgotten. Knowing that you were willing to manage our household activities while I completed my Doctoral program was a great comfort and relief. You deserve a trip to Disney!

Furthermore, I deeply acknowledge and remain grateful to the Rector of Rufus Giwa Polytechnic Owo, Mr. Gani Ogundahunsi and his Management, the Head, Department of Surveying and Geoinformatics Rufus Giwa Polytechnic Owo, as well as the TETFund for their administrative and financial assistance towards my Ph.D. career. Finally, to the Ondo State Ministry of Works, Lands and Housing, and the Federal Road Safety Corps (FRSC) Akure Command, I thank you for providing me with the information needed to complete this research work. And to my friends and families, thank you.

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ABSTRAK

Kajian ini menangani isu kesesakan lalu lintas jalan bagi persimpangan dan ciri sosio-ekonomi di sepanjang jalan di sepanjang persimpangan Oloko-Irese-Agbogbo di lebuh raya Benin-Owo Negeri Akure Ondo, Nigeria. Sampel lapangan dikumpul dengan kaedah tinjauan tanah memerhati sampel permukaan dibantu oleh Sistem Penentududukan Global (GPS) dan 250 soal selidik telah diedarkan untuk mendapatkan maklumat tentang profil responden, latar belakang aktiviti sosio-ekonomi, pendekatan pengurusan agensi kerajaan untuk mengurangkan kesesakan lalu lintas, persepsi kesesakan lalu lintas jalan raya, dan jarak persimpangan di jalan raya. Kajian ini meneroka kesesakan lalu lintas yang dialami di persimpangan Oloko-Irese-Agbogbo di lebuh raya Ilesa-Benin di Akure, Negeri Ondo, Nigeria. Ia memberikan pandangan mengenai faktor-faktor yang menyumbang kepada kesesakan lalu lintas jalan raya dan kesan-kesannya terhadap pengguna jalan. Selain itu, ia membentangkan cadangan-cadangan untuk mengurangkan kesesakan lalu lintas di kawasan tersebut. Data Geometri yang diperoleh dengan menggunakan GPS dan data atribut yang diperoleh membantu pembinaan pangkalan data menggunakan perisian ArcGIS 10.3 untuk buffering. Keputusan kajian ini menunjukkan bahawa infrastruktur jalan yang tidak mencukupi, pertambahan penduduk, sistem pengangkutan yang buruk, dan kurangnya penguatkuasaan yang sesuai terhadap peraturan lalu lintas adalah beberapa punca utama kesesakan lalu lintas di kawasan ini. Selain itu, hasil kajian menunjukkan bahawa ramai responden mengaitkan kesesakan lalu lintas yang berterusan di kawasan kajian dengan tahap kecekapan agensi kerajaan yang rendah. Tambahan pula, didapati

bahawa kesesakan lalu lintas memberi kesan negatif peningkatan masa dan kos perjalanan untuk pengguna jalan. Penemuan menunjukkan bahawa kebanyakan responden mengalami kesesakan lalu lintas setiap hari dan menghabiskan purata 20 minit dalam kesesakan berat dan 15 minit dalam kesesakan jarang. Penemuan ini mencadangkan bahawa pelaksanaan undang-undang yang sedia ada, pelaburan dalam infrastruktur, dan peningkatan sistem pengangkutan boleh membantu mengurangkan kesesakan lalu lintas di persimpangan Oloko-Irese-Agbogbo. Kajian ini memberikan pandangan mengenai kesesakan lalu lintas jalan raya di Nigeria yang boleh digunakan oleh pembuat polisi dan pihak berkepentingan bagi menyediakan strategi yang berkesan dalam meningkatkan sistem pengangkutan di Nigeria sambil mengurangkan tahap pencemaran udara di seluruh negara.

ROAD TRAFFIC CONGESTION ANALYSIS AT OLOKO-IRESE-AGBOGBO JUNCTIONS ON ILESA-BENIN HIGHWAY AKURE ONDO STATE, NIGERIA

ABSTRACT

The study addressed road traffic congestion issues of junctions and socio-economic characteristics along the road along Oloko-Irese-Agbogbo junctions in the Benin-Owo highway Akure Ondo State, Nigeria. Field samples were collected by ground survey methods observing surface samples aided by a Global Positioning System (GPS) and 250 questionnaires were distributed to elicit information about respondents' profiles, background socio-economic activities, government agencies' management approach for reducing traffic congestions, perception of road traffic congestion, and junctions' distance apart on the road. It explores the traffic congestion experienced at the Oloko-Irese-Agbogbo junctions on the Ilesa-Benin highway in Akure Ondo State, Nigeria. It provides insights into the factors contributing to road traffic congestion and its effects on commuters. In addition, it presents the proposed solutions for reducing traffic congestion in the area. The Geometric data captured using GPS and attribute data obtained aided database creation using ArcGIS 10.3 software for buffering. The results of this survey indicated that inadequate road infrastructure, overpopulation, poor transportation system, and lack of appropriate enforcement of traffic rules are some of the major causes of traffic congestion in this area. Also, results showed that many of the respondents attributed the constant traffic congestion in the study area to the poor level of efficiency of the government agencies. Furthermore, it was discovered that traffic congestion has negative impacts, such as increased travel time and cost for commuters. The finding showed that most of our

respondents get stuck in traffic daily and spend an average of 20 minutes in heavy traffic and 15 minutes in seldom traffic cases. The findings suggest that adequately implementing existing laws, infrastructure investment, and transportation system improvement can help reduce traffic congestion at the Oloko-Irese-Agbogbo junctions. This study provides valuable insights into road traffic congestion in Nigeria which policymakers and stakeholders can use to develop effective strategies for improving transportation systems in Nigeria while also reducing air pollution levels across the country.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This study focused on the problem of road traffic congestion, specifically at junctions. This research aimed to conduct road traffic congestion analysis and database generation to buff off the Oloko-Irese-Agbogbo junctions on the Ilesa-Benin highway in Akure Ondo State, Nigeria, against traffic congestion. The current chapter is organized as follows: The research background provides a contextual foundation for the study, highlighting the existing knowledge and gaps in the field. It serves as a basis for identifying the research problem, a specific issue, or gap(s) the study aims to address. The problem statement articulates the significance and relevance of the research problem, emphasizing its importance in the broader academic or practical context. Research objectives outline the specific goals or aims of the study. The study elucidates the research scope, importance, anticipated results, and operational definitions and provides a concise summary.

1.2 Research Background

The issue of vehicle traffic congestion in Nigeria's metropolitan areas has garnered significant attention and has been extensively documented in numerous research studies and publications. It is widely recognized and acknowledged as a pressing concern that requires immediate attention and practical solutions. The study conducted by the World Bank in 2015 revealed several significant challenges plaguing the urban transport system in Nigeria. These challenges encompass a range of issues, including but not limited to traffic congestion, substandard road conditions, inadequate public transport infrastructure, and a lack of integrated planning and coordination. One

of the foremost issues identified in the study is the problem of traffic congestion. Furthermore, it is worth noting that a multitude of studies and scholarly publications have extensively examined and shed light upon various underlying factors that significantly contribute to the pervasive issue of road traffic congestion in Nigeria.

These comprehensive investigations have meticulously identified and analyzed the multiple causes that exacerbate the problem, thereby providing valuable insights into the complex nature of this phenomenon. A number of critical issues can be identified when examining the challenges related to traffic management and road safety. These issues encompass a range of concerns, such as inadequate infrastructure, a shortage of effective enforcement mechanisms, and a prevailing disregard for established traffic norms and regulations. Each of these factors contributes to the complex and multifaceted nature of the problem. The research conducted by Oluwadamisi et al. (2018) shed light on the various factors contributing to traffic congestion in Lagos, Nigeria. The study revealed that the insufficiencies in road infrastructure, ineffective traffic management, and limited availability of public transit play significant roles in exacerbating the city's traffic congestion problem. One of the key findings of the research was the inadequate road infrastructure in Lagos.

Furthermore, it is worth noting that a recent study conducted by the esteemed Federal Road Safety Corps (FRSC) of Nigeria has shed light on a notable and noteworthy phenomenon. Specifically, this study has revealed a substantial and remarkable increase in the sheer volume of automobiles navigating the intricate and extensive road networks within the borders of Nigeria. The number of cars has exceeded a significant milestone, surpassing the 50 million mark, as documented. The exponential increase in the number of automobiles has significantly escalated traffic congestion, particularly on well-known road networks such as the Ilesa-Benin

motorway. This surge in vehicular traffic has become a pressing issue, causing various challenges and disruptions to the efficient flow of transportation systems.

Furthermore, it is important to acknowledge that numerous factors have contributed to the heightened traffic congestion observed at the Oloko-Irese-Agbogbo intersections. Several factors contribute to the challenges encountered in the transportation sector. One of these factors is the substandard condition of roadways. Many roads suffer from poor maintenance, leading to potholes, cracks, and uneven surfaces. These conditions affect the comfort and safety of travelers and result in increased vehicle wear and tear, leading to higher maintenance costs for transportation companies and individuals. Another factor contributing to the substantial traffic congestion at these intersections leads to many detrimental outcomes, encompassing prolonged travel times, increased consumption of fuel resources, and escalated levels of air pollution. As mentioned earlier, the repercussions significantly impact various aspects, namely the economy, environment, and the overall well-being of the local inhabitants.

The occurrence of road traffic congestion at the Oloko-Irese-Agbogbo junctions along the Ilesa-Benin route can be attributed to a multitude of factors. These factors encompass a wide range of influences contributing to the congestion experienced in this area. One of the primary factors contributing to the issue at hand is the inherent inadequacy of the junction's design and its limited capacity to effectively manage and accommodate the substantial volume of traffic traversing through it (Balogun et al., 2019). Furthermore, it is worth noting that the Oloko-Irese-Agbogbo junctions are strategically positioned within a densely populated area known for its significant commercial and residential activities. This particular geographical setting

renders these intersections particularly susceptible to experiencing high levels of traffic congestion.

Throughout history, governmental entities entrusted with the responsibility of supervising and managing road infrastructure have implemented many strategies and measures to address the persistent issue of traffic congestion at various junctions. These solutions have been devised and implemented to enhance the efficiency and functionality of transportation systems, thereby ensuring the smooth flow of vehicular traffic. Over the years, numerous strategies have been implemented with the primary objective of improving the efficiency and safety of road networks. These strategies have been developed and implemented by transportation authorities and policymakers in response to the growing challenges and demands placed on road infrastructure. One prominent strategy that has been widely adopted is the implementation of intelligent transportation systems (ITS). ITS encompasses a range of advanced technologies and appliances. A range of measures have been implemented to address the challenges posed by increased traffic volume. These measures encompass various strategies aimed at improving traffic flow and ensuring the safety of road users. One approach involves expanding the lanes leading to junctions.

By increasing the capacity of these lanes, the aim is to accommodate the growing number of vehicles and alleviate congestion. This expansion allows for a smoother and more efficient movement of traffic. Various supplementary measures have been implemented to address the challenges posed by high traffic demand. One such measure involves constructing additional road infrastructure specifically designed to accommodate the increased flow of vehicles during periods of peak demand. This approach has been acknowledged and discussed in the academic literature, as evidenced by Olawumi's (2018) and Oludare et al. (2019) works. These

scholars have highlighted the importance of constructing additional road infrastructure to accommodate the increased flow of vehicles during periods of peak demand. The study conducted by Badejo et al. (2020) provides empirical evidence suggesting that specific strategies have proven to be successful in alleviating traffic congestion at the Oloko-Irese-Agbogbo Junctions, which are located along the Ilesa-Benin Highway in Akure, Ondo State, Nigeria. The researchers have examined the effectiveness of various approaches in addressing this issue and have found positive outcomes.

A compelling and illustrative example can be observed in a recent study conducted by Adebayo et al. (2020), wherein they investigated the effectiveness of implementing speed humps as a measure to address instances of speeding at Junctions. This research provides valuable insights into the efficacy of such interventions in promoting road safety and reducing the occurrence of speeding-related incidents. By examining the impact of speed hump implementation, the study contributes to the existing body of knowledge on traffic management strategies. It offers practical implications for policymakers and urban planners seeking to enhance road safety measures. The findings of this study shed light on the potential benefits of speed humps in mitigating speeding behaviors, thereby emphasizing the importance of considering this intervention as part of comprehensive traffic management approaches. Implementing this intervention yielded positive outcomes, as it led to a notable reduction in accidents and effectively mitigated instances of road anger. These two interconnected outcomes, namely the decrease in accidents and the alleviation of road anger play significant roles in the overall issue of traffic congestion.

However, it is crucial to recognize ample room for enhancement, as numerous policies remain inadequately executed or enforced. This can primarily be attributed to financial limitations or an absence of political resolve among the pertinent governing

bodies. Despite utilizing various strategies and approaches, the persistent problem of road traffic congestion at the Oloko-Irese-Agbogbo junctions along the Ilesa-Benin route remains a significant impediment. One important contributing factor to the issue is the remarkable increase in the number of vehicles utilizing the road networks. This surge in car volume has resulted in a situation where the existing junctions and intersections can no longer adequately accommodate and regulate traffic flow.

As a consequence, the capacity of these junctions has become insufficient to manage the ever-growing demand for smooth and efficient transportation effectively. In addition, it is worth noting that there has been a notable deficiency in the provision of adequate maintenance for traffic control measures, particularly in relation to traffic lights. This lack of proper upkeep has resulted in the malfunctioning of these crucial devices, thereby exacerbating the already challenging traffic management situation. The current situation has imposed an overwhelming amount of responsibilities on traffic wardens, thereby intensifying the problem of traffic congestion.

A study conducted by Oluwagbemi et al. (2020) examining the factors influencing traffic congestion in Akure revealed several vital contributors. These factors were identified as insufficient infrastructure, ineffective traffic management strategies, and escalating vehicles within the region. This research shed light on the complex dynamics that underlie the persistent traffic congestion issue in Akure, highlighting the need for comprehensive interventions. The research study proposed a pressing requirement for the adoption and execution of a comprehensive and enduring transportation strategy that duly considers the integration of non-motorized transportation options and a reduction in the reliance on private vehicles.

In a recent empirical study conducted by Adeniji et al. (2021), the researchers sought to investigate the impact of the COVID-19 pandemic on traffic congestion

levels in Lagos, Nigeria. The study aimed to shed light on the changes in traffic patterns and congestion dynamics due to the unprecedented disruptions caused by the pandemic. By examining the specific context of Lagos, a densely populated and highly urbanised city, the researchers aimed to contribute to the growing The findings of the study indicate that the implementation of stringent lockdown measures in response to the global pandemic had a significant and noteworthy impact on mitigating traffic congestion. The imposition of these measures, which included restrictions on movement and non-essential activities, resulted in a considerable reduction in the volume of vehicles on the roads. As a result, traffic congestion levels experienced a marked decrease during the period of lockdown implementation. This outcome underscores the effectiveness of such measures in curbing traffic congestion, highlighting the potential benefits of implementing similar strategies in the future to alleviate traffic-related issues. The report put forth the argument that it is imperative for the government to prioritise the implementation of sustainable transport alternatives in order to effectively address and alleviate the persistent issue of long-term traffic congestion.

At the global level, many strategies and methodologies have been employed to alleviate traffic congestion at intersections effectively. Intelligent transportation systems (ITS) encompass a range of advanced technologies and methods that leverage data acquired from strategically positioned sensors along roadways to observe, analyse, and manage traffic patterns efficiently. By harnessing this wealth of information, ITS enables the implementation of proactive measures to optimize the flow of vehicles, enhance safety, and mitigate congestion on road networks. These systems rely on the integration of various components. In addition to regulating traffic flow, adaptive signal control systems are crucial in dynamically adjusting signal timing

to align with changing traffic conditions. These systems are designed to respond to real-time data and make informed decisions to optimize traffic operations and enhance overall efficiency. By continuously monitoring traffic patterns and adjusting signal timings accordingly, adaptive signal control systems contribute to the reduction. In addition to the measures above, it is worth noting that numerous metropolitan regions have adopted various strategies to mitigate the negative impacts of private vehicle usage and promote the utilization of public transportation options.

These strategies encompass the creation of dedicated carpooling lanes, the introduction of ride-sharing services, and the implementation of tolls, all of which are designed to incentivize individuals to opt for alternative modes of transport. Assessing the effectiveness of these techniques poses a significant challenge due to the complex and multifaceted nature of road traffic congestion. This issue is compounded by the presence of numerous factors that influence congestion levels. However, it is important to note that recent studies have provided evidence suggesting that implementing intelligent transport systems (ITS) holds promise in effectively alleviating the negative consequences of road congestion. This assertion is supported by the findings of Almahdi et al. (2019) and Chen et al. (2020), who have researched this area. Their studies have shed light on the potential of ITS to mitigate the adverse effects of road congestion.

In recent years, there has been a growing recognition of the significance of adaptive signal management systems in transportation. Notably, empirical evidence has demonstrated these systems' crucial role in effectively reducing automobile travel time (Yoo & Sugiyama, 2020). This finding underscores the importance of implementing adaptive signal management systems to optimize traffic flow and enhance overall transportation efficiency. Therefore, it is of utmost importance for

governments worldwide to consistently allocate substantial resources towards implementing various measures to mitigate road traffic congestion effectively. This is crucial to facilitate the seamless transportation of goods and individuals within urban areas. By prioritizing the allocation of resources, governments can actively address the challenges posed by increasing traffic congestion, which has become a pressing issue in man.

The issue of traffic congestion in Nigeria has become increasingly problematic due to the significant growth in population and urbanization. This has led to a notable increase in the volume of vehicles navigating the roadways, further exacerbating the problem. The phenomenon of urbanization has brought about the expansion of urban areas, leading to a continuous and enduring strain on road transport infrastructure. Consequently, this has given rise to the prevalent and pressing issue of traffic congestion, which has become a matter of great significance and concern in numerous large cities across the globe (Taylor et al., 2018).

The study conducted by Joshua and colleagues (2016) provides valuable insights into the escalating traffic volume in emerging nations. Their research highlights a persistent trend wherein the growth in traffic volume has consistently outpaced the capacity of authorities to expand road infrastructure. This imbalance between traffic demand and road capacity poses significant challenges to the efficient functioning of urban economies in these nations. The findings of Joshua et al. (2016) shed light. Therefore, to tackle the traffic congestion problem effectively, it is widely recognized within the academic community that the initial step in this undertaking entails the meticulous identification and analysis of congestion characteristics. This crucial stage is a foundation for devising appropriate strategies and implementing targeted interventions to alleviate congestion and enhance transportation systems. The

aforementioned phase, commonly acknowledged as being of utmost importance, holds a significant role in the realm of transportation planning. It serves as a fundamental guide, providing essential insights and recommendations for developing appropriate strategies to mitigate the issue of congestion.

This assertion is supported by the scholarly work of Iroham et al. (2019), who has extensively studied and analyzed the subject matter. Junctions, which are defined as areas where multiple roads intersect, are notable for their high traffic volume and the resulting congestion. This congestion, which typically ranges from 40% to 60%, is a prevalent issue in many countries worldwide, as reported by the European Commission Transport Road Safety in 2020. It is important to note that road intersections, which are points where two or more roads meet, are susceptible to experiencing increased levels of traffic congestion in various urban areas across the globe, regardless of whether they are well-established or still in the process of development (Aderamo & Atomode, 2012). Hence, it is of utmost importance to allocate considerable attention to the identification of various types of junctions, the quantification of junctions along a road axis, and the optimal design of each junction.

This emphasis is crucial as it aims to facilitate the smooth traffic flow effectively. By focusing on these key aspects, transportation planners and engineers can ensure that road networks are designed and constructed to maximize efficiency and minimize congestion. Junctions, also commonly known as intersections, are crucial elements of road networks that facilitate the convergence and divergence of multiple roadways. These junctions can be classified into various types based on the number of roads they connect. Examples include three-road junctions, four-road junctions, five-road junctions, and even more complex configurations. The significance of junctions lies in their ability to enhance traffic flow efficiency, promote

safe navigation, and enable effective traffic flow. The intersections under consideration in this study are distinguished by the convergence of multiple roads, resulting in a complex network of vehicular movement. The regulation of traffic flow at these junctions is typically managed by either traffic police officers or traffic lights, both of which play crucial roles in ensuring the smooth and efficient operation of the transportation system (Singha & Kalita, 2016).

When examining the issue of congestion and safety in metropolitan road networks, it becomes evident that junctions play a crucial role. These junctions, where multiple roads converge, serve as pivotal points that facilitate traffic flow and ensure motorists' safety. Consequently, understanding the significance of junctions in metropolitan road networks is essential for effective urban planning and transportation management. According to Owolabi, Oyedepo, and Okoko (2016), junctions frequently serve as locations where potential hazards may arise due to the complex interactions that take place between traffic streams moving in different directions.

These junctions are characterized by the presence of multiple traffic streams that often have conflicting movements, resulting in a heightened risk of accidents and collisions. The intricate dynamics of these interactions, involving vehicles traveling in various directions, pose significant challenges for traffic management and safety. Consequently, intersections demand careful planning, design, and implementation of appropriate traffic control measures to mitigate the potential risks associated with these competing traffic movements.

Furthermore, it is important to note that, as illustrated in Figure 1.0, the convergence of vehicular flows from various directions at junctions leads to the simultaneous occupation of a shared physical space. This phenomenon occurs when vehicles from different approaches come together at a junction, causing them to

occupy the same area simultaneously. This particular phenomenon gives rise to an increased volume of vehicles, thereby leading to both the worsening of traffic congestion and the consequent prolongation of waiting times for the uninterrupted stream of cars. According to Singha and Kalita (2016), a traffic stream is a coherent and continuous flow of vehicles moving in a specific direction along a road, typically facilitated by a junction. This concept encompasses the dynamic movement of vehicles within a given transportation network, where vehicles are organized into a cohesive stream based on their shared directionality and movement patterns. By characterizing a traffic stream as a collection of vehicles

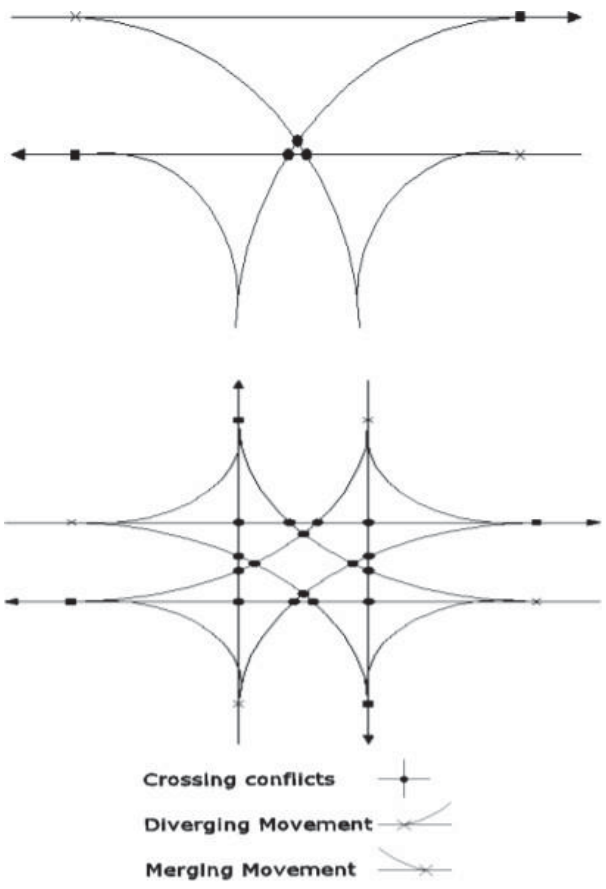

Figure 1.1 Types of movement at junctions

(Source:- Owolabi et al.,2016)

Based on the above Figure 1.1, it becomes evident that Types of movement at junctions, such as crossing conflicts, diverging movements, and merging movements, play a crucial role in traffic flow and safety. These movements can be better understood and analyzed using Geographic Information System (GIS) technology, which offers valuable tools for data visualization, spatial analysis, and decision-making in transportation planning and management.

Crossing Conflicts:

Crossing conflicts occur at intersections where different streams of traffic cross paths. This often involves vehicles moving in different directions, such as a four-way intersection or a roundabout. GIS can be utilized to map and visualize the spatial distribution of crossing conflicts at various junctions. By analyzing the frequency and severity of conflicts, transportation planners can identify high-risk areas and implement appropriate measures to reduce accidents and enhance traffic flow. GIS can also help simulate traffic scenarios, taking into account different timings of signal phases, traffic volumes, and turning movements to optimize intersection design and signal timing for minimizing crossing conflicts.

Diverging Movements:

Diverging movements involve vehicles leaving the main road and turning into side streets or driveways. These movements often occur at intersections with right-turn lanes or slip lanes. GIS can be used to analyze the spatial patterns of diverging movements and identify potential bottlenecks or safety concerns.

Through GIS analysis, transportation planners can assess the capacity of turn lanes, predict potential congestion points, and optimize lane configurations to improve traffic flow during peak hours. GIS can also be used to evaluate the impact of new

developments on diverging movements, helping in the decision-making process for infrastructure development.

Merging Movements:

Merging occurs when vehicles from different directions join the same lane, such as at freeway ramps or acceleration lanes. GIS can assist in analyzing the merging behavior of vehicles, understanding the impact of different ramp geometries, and evaluating the effectiveness of existing merging zones.

By using GIS to model traffic flow and simulate different merging scenarios, transportation planners can optimize ramp designs, merge lengths, and merge angles to enhance safety and traffic efficiency. GIS can also support real-time monitoring and management of merging movements, helping to identify congested areas and make timely adjustments to traffic signals and lane usage.

In summary, GIS provides valuable insights into the types of movement at junctions, including crossing conflicts, diverging movements, and merging movements. Transportation planners and policymakers can use GIS technology to make data-driven decisions to improve traffic safety, efficiency, and overall transportation network performance. GIS-based analysis allows for a better understanding traffic patterns, identifying potential issues, and developing practical solutions to enhance junction design and management. Moreover, the advent of the Geographic Information System (GIS) during the 1970s marked a significant turning point in the realm of geography and planning, as it brought about a revolutionary transformation by equipping professionals with advanced spatial analysis capabilities and facilitating enhanced decision-making processes. With its introduction, GIS emerged as a powerful tool that harnessed the potential of geospatial data, enabling

researchers, planners, and policymakers to gain valuable insights into the spatial relationships and patterns that underpin various phenomena.

By integrating diverse datasets and employing sophisticated analytical techniques, GIS facilitated a more comprehensive understanding of geographical phenomena, facilitating more informed and effective decision-making processes in geography and planning. Consequently, the development and widespread adoption of GIS have profoundly impacted these disciplines, empowering professionals to tackle complex spatial challenges and contribute to the sustainable development and management of our built and natural environments. According to Longley, Goodchild, Maguire, and Rhind (2015), Geographic Information Systems (GIS) allow users to manage spatial data effectively by organizing it into layers and enabling the execution of intricate spatial analyses through overlaying these layers. By employing GIS, individuals are empowered to manipulate and analyze data in a spatial context, thereby facilitating a deeper understanding of the relationships and patterns within the data.

The utilization of Geographic Information Systems (GIS) encompasses many advantages beyond its user-friendly visual access and display capabilities. While the ability to quickly visualize and interpret spatial data is undoubtedly a significant benefit, there are several other noteworthy advantages associated with applying GIS technology. GIS enables users to analyse and evaluate complex relationships between different variables by integrating various geographic data layers. This spatial analysis capability empowers decision-makers to make informed choices based on a comprehensive understanding of the geographical context and its associated factors.

Consequently, GIS aids in enhancing the accuracy and efficiency of decision-making. However, it is important to note that these GIS applications encompass a wide range of standard functionalities commonly utilized in the field. These functionalities

include but are not limited to buffering, network-level analysis, thematic mapping, charting, and the ability to access multiple data layers simultaneously. Furthermore, it is worth noting that Geographic Information Systems (GIS) can establish connections with external programmes and software, enhancing their functionality in various domains such as decision-making, data management, and user-specific functions (Bolstad, 2016).

This integration with external tools allows GIS to effectively support decision-making processes by providing access to additional data sources and analytical tools. Moreover, the ability to interface with external software enables GIS to efficiently manage and manipulate large volumes of spatial data, facilitating effective data management practices. This integration also allows GIS to cater to individual users' specific needs and requirements, thereby enhancing its usability and versatility in diverse applications (Bolstad, 2016).

One of the most notable advancements in Geographic Information Systems (GIS) is its remarkable capability to generate buffer zones around various geographic features, such as road junctions. This functionality enables the identification and delineation of areas that may potentially be affected or influenced by these features. By employing GIS technology, analysts and researchers can effectively assess and analyze these buffer zones' spatial relationships and potential impacts, enhancing decision-making processes and facilitating informed planning and management strategies. An illustration of integrating a road layer with a land-use layer can be observed in the context of buffering procedures. This integration facilitates the identification of specific areas that may be impacted by various factors, such as increased journey times and air pollution resulting from road traffic congestion (Bolstad, 2016).

In addition to its advantages in spatial database management and transit analysis within the field of traffic management, Geographic Information Systems (GIS) offer further benefits. One such advantage is the ability to utilize prepared thematic maps to visually represent the underlying causes of traffic congestion. By employing GIS, it becomes possible to identify and display factors such as improper parking locations, the need for alternate routes, and the potential negative impact of the establishment of new commercial zones, which will not only minimize traffic congestion at junctions but also support urban growth (Mazzi Lydia, Kayondo Ndandiko, 2011).

The followings keywords used in this thesis are defined as follows:

i. Traffic Congestion: - This is defined as traffic moving at well below the legal maximum speed, which is familiar on peak period roads and highways in urban areas worldwide (Bern et al. 2018).

ii. Junctions: - As defined by O'Flaberty (1997), these are points where two or more roads meet and a place of vehicle conflict. Similarly, Mchsare et al. (1998) noted many potential and actual disputes at no other location within the street and highway systems other than at road intersections.

iii. GIS: - Geographic Information System (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on the Earth's surface. Using tools such as GPS, Imageries, and a variety of software such as ArcGIS that can show many kinds of data on one map, such as roads, rivers, buildings, and vegetation, which enables people to more easily see, analyze, and understand patterns and relationships (National Geographic, 2020).

1.3 Problem Statement

The road traffic congestion analysis at the Oloko-Irese-Agbogbo junctions on the Ilesa-Benin Highway in Akure, Ondo State, Nigeria, holds significant importance owing to its profound implications for transportation efficiency, environmental sustainability, and the socioeconomic fabric of the local community. The real issue and situations at the Oloko-Irese-Agbogbo junctions along the Ilesa-Benin Highway in Akure, Ondo State, Nigeria, are facing persistent road traffic congestion, adversely affecting the flow of vehicular traffic in the area. This traffic congestion issue has significant economic, social, and environmental implications, making it imperative to address. Several factors contribute to the road traffic congestion in this region, including Insufficient Road infrastructure and outdated road design. High population growth and urbanization in the vicinity. A lack of efficient traffic management and enforcement. Inadequate public transportation systems. Frequent road accidents and breakdowns. Inefficient intersection design and traffic signals.

In spite of the various interventions implemented by the government, the issue of traffic congestion continues to persist as a significant challenge at the critical intersections in Akure. For example, In the studies of (Mabogunje,1968; Onakomaiya, 1979; Odeleye, 2001; Ogunsanya, 2002; Oni 2004; Adalemo, 2005) of major cities in Nigeria, cited in Joshua et al. (2016) study of Akure, road traffic congestion is enervating and it has continued to defy every solution and government strategy including that of government's agencies such as Federal Road Safety Commission (FRSC), Vehicle Inspection Office (VIO), and Police Road traffic warden, approaches introduced over the years in major cities like Akure. Also, efforts to mitigate road traffic congestion at the Oloko-Irese-Agbogbo junctions have included Road expansion and maintenance projects. Urban planning initiatives aimed at decongesting

the area. Implementation of traffic management measures, such as roundabouts and traffic signals. Promotion of public transportation, including school free bus shuttle. Awareness campaigns and enforcement of road safety regulations.

Despite these strategies and measures, road traffic congestion persists at the Oloko-Irese-Agbogbo junctions. This persistence can be attributed to Rapid population growth outpacing infrastructure development. Lack of coordinated and sustained efforts in traffic management. Challenges in enforcing traffic regulations and ensuring compliance. Limited resources and funding for comprehensive transportation improvements. Inadequate data and analysis to guide evidence-based interventions. Consequently, it becomes imperative to thoroughly analyze the government's approach to road traffic management in the city. However, by undertaking such an examination, we can comprehensively understand the factors contributing to the persistent traffic congestion and identify potential areas for improvement in the government's strategies and policies.

There has been a shortage of comprehensive research conducted on the city of Akure, particularly in relation to its traffic management system. Consequently, the present study fills this void by thoroughly examining the existing traffic management framework's strengths, weaknesses, opportunities, and threats. The present study examined the potential relationship between the proximity of two junctions on the highway, which are separated by a distance of less than one kilometer, and the persistent issue of traffic congestion. Additionally, this research seeks to explore the efficacy of implementing buffer zones, such as roundabouts, to enhance traffic flow in this context. By investigating these factors, the study aims to contribute to the existing body of knowledge on traffic management and provide insights into potential strategies for mitigating congestion on highways with closely spaced junctions.

The ongoing road traffic congestion issue and situations at the Oloko-Irese-Agbogbo junctions along the Ilesa-Benin Highway in Akure, Ondo State, Nigeria, negatively impact the tourism industry in the region. Akure, Ondo State, has several natural and cultural attractions (such as the Idanre Hills yearly cultural festivals in Akure and surrounding towns) that could be a significant source of tourism revenue. However, the traffic gridlock deters tourists, resulting in potential revenue loss from tourists who avoid the area due to congestion. A diminished tourism experience as visitors face prolonged travel times. A negative impact on the overall image and appeal of the region as a tourist destination. Understanding the persistence of road traffic congestion and its consequences on the tourism industry is essential for formulating effective policies and strategies to alleviate the issue and foster economic growth in the area. Therefore, further research and analysis are required to identify specific interventions and evaluate their effectiveness in addressing the congestion problem and enhancing the tourism sector.

Therefore, the research objectives of this study were successfully accomplished by conducting a comprehensive and in-depth examination of pertinent scholarly literature on traffic congestion, road transport management, and road safety. This involved a meticulous and thorough review of various academic sources, including scholarly articles, books, and reports, providing valuable insights and knowledge. The research objectives were effectively met by delving into the existing body of literature, enabling a comprehensive understanding of the subject matter and facilitating the development of informed conclusions and recommendations. Numerous scholarly investigations have shed light on the issue of traffic congestion, identifying it as a significant and formidable obstacle urban areas face. This pervasive

problem exerts its influence on various aspects of urban life, including travel time, goods transportation, and the affected regions' overall socio-economic vitality.

The escalating prevalence of car utilization and inadequate transportation planning are significant factors that contribute to the problem of congestion, rendering it a multifaceted and intricate issue within urban centers throughout Nigeria. Previous studies conducted on the issue of traffic congestion in Akure have proposed the implementation of dynamic Traffic Information Systems (TIS) as a potential solution to effectively monitor and disseminate information regarding traffic congestion to road users. These TIS systems are designed to provide real-time updates on traffic conditions, enabling drivers to make informed decisions and potentially alleviate congestion on the road network. The utilization of such systems has been recommended based on the belief that improved awareness and knowledge of traffic conditions can lead to more efficient traffic flow and reduced congestion levels in Akure.

Nevertheless, it is important to acknowledge that while these approaches have proven effective in certain contexts, they are not without limitations. One such limitation is the reliance on radio stations as a means of dissemination, which may not effectively reach all road users. This is particularly true in areas where access to radio stations is limited or where individuals may not have the means to access radio broadcasts. Consequently, the effectiveness of these approaches in disseminating road safety information to all road users may be compromised. Therefore, it is crucial to consider alternative methods of communication that can reach a wider audience and ensure that road safety messages are effectively conveyed to all individuals, regardless of their access to traditional media channels.

1.4 Research Aim and Objectives

This research's primary aim and objectives were to investigate and analyze the traffic congestion at the Oloko-Irese-Agbogbo junctions along the Ilesa-Benin highway in Akure, Ondo State, Nigeria. The following objectives were formulated to serve as a guiding track to reach the aim of the study.

i. To examine the government agency's approach to road traffic management activities in Akure.
ii. To determine the relationship of continuous traffic congestions at the junctions resulting from less than a kilometer distance between two junctions in Akure.
iii. To generate a database for the purpose of buffering Oloko-Irese-Agbogbo junctions on the Ilesa-Benin highway as feasible solutions and countermeasures to road management towards a better road traffic system at the junctions in Akure.

These objectives were designed to serve as a guiding track, providing a clear and structured pathway toward the desired outcome. By delineating these objectives, the study aims to establish a framework that will facilitate the systematic exploration and analysis of the research topic by thoroughly investigating the causes and efforts of traffic congestion in the study area to achieve the study's overarching goal effectively.

1.5 Research Questions

In accomplishing the research goals, answers were provided to the following questions.

i. What is the government agency's approach to road traffic management activities in Akure?

ii. Are the continuous traffic congestions at the junctions due to less than a kilometer distance between two junctions?

iii. How can database creation be useful in buffering procedures on traffic congestion and road traffic systems at the Junctions?

1.6 Research Scope

The research focussed on the Oloko-Irese-Agbogbo junctions along the Ilesa-Benin Highway in Akure, Ondo State, Nigeria. The study area is marked by high traffic congestion and its impact on the local transportation network. The primary aim of this research endeavor is to undertake a thorough investigation and analysis of the magnitude of traffic congestion encountered at the junctions of Oloko, Irese, and Agbogbo along the Ilesa-Benin Highway, which is located in Akure, Ondo State, Nigeria. The study provided a comprehensive examination of the prevailing traffic conditions at these specific intersections, with the intention of gaining a deeper understanding of the factors contributing to the congestion. This analysis obtained valuable insights regarding the causes and potential solutions to alleviate the traffic congestion in this area. Also, by conducting a thorough investigation and analysis, this study uncovers the various elements and variables that played a significant role in the manifestation of traffic congestion in this region.

1.7 Study Area (Location and Size)

Since Akure assumed the role of the administrative capital of Ondo State, there has been a substantial and more than threefold increase in its population. In 1963, Akure's population stood at around 71,106, escalating to 239,124 in 1976, maintaining the exact figure in 1991, and surging further to 360,268 in 2006 (Owoeye and Ibitoye,

2016). As of 2021, the metropolitan population of Akure reached 691,000, reflecting a 3.75% rise from the previous year (UN World Population Prospect 2022). The land use within the study area is categorized into four distinct classifications, encompassing the built-up area (comprising residential, commercial, industrial, recreational, and educational land uses), dense vegetation (forested land areas), sparse vegetation (cultivated land areas), and aquatic bodies (such as rivers and streams).

The study area for this research is the Oloko-Irese-Agbogbo junctions on the Ilesa-Benin Highway in Akure, Ondo State, Nigeria. Figures 1.2, 1.3, and 1.4 show Nigeria, Ondo State, and its 18 Local Government Areas, Akure North & Akure South Local Government Areas Road Network, and Locational map of the study area in the regional setting, respectively. The Oloko-Irese-Agbogbo junctions constitute the study area for this research on road traffic congestion because this Location is a critical transportation hub for the state, experiencing heavy traffic congestion regularly. In addition, Oloko-Irese-Agbogbo junctions are among the busiest sections of the highway. The Ilesa-Benin Highway is a vital road network that connects the city to neighboring towns and states, experiencing heavy traffic congestion daily, leading to travel delays, accidents, and loss of productivity due to several factors contributing to the traffic congestion problem at these junctions. These include inadequate road infrastructure, lack of traffic lights and roundabouts, and roadside traders' indiscriminate parking by commercial vehicles (Ajayi et al., 2019). These factors have resulted in a significant reduction in road capacity, leading to congestion and delays.

This study analyses and provides solutions to the traffic congestion problem experienced at these junctions. Recent studies have shown that traffic congestion is a global phenomenon that poses significant challenges to urban transportation systems (Banerjee et al., 2021). The problem is more pronounced in Nigeria due to the lack of