# Spatial Characterization of Road Accident Hotspots in Ado-Ekiti, Nigeria

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## ABSTRACT

In developing nations, some of the common urban transport problems include: traffic congestion and delays; road traffic accidents; air and noise pollution; and indiscriminate parking, among others. This paper assessed the pattern of road accident hotspots in Ado-Ekiti, Nigeria with a view to offer insights into the character of road accidents in the study area. Primary data sources for this study include: coordinates of accident hotspots generated using Global Positioning System (GPS); field observations; interview guides administered on staff of the Federal Road Safety Corps and the State General Hospital, Ado-Ekiti. Secondary data sources include data from existing literature, published journal articles; online resources; and documented materials on road accident reports collected from the Federal Road Safety Corps office. Using the Taro Yamane sample size determination formula, the multistage sampling procedure was used to administer 400 questionnaires on road users and residents in the study area. This paper revealed that infrastructure decay coupled with poor maintenance and human error are the major causes of road accidents in the identified hotspots. The paper therefore, canvases the promotion of public awareness campaigns to educate road users on traffic rules, hazard zones, and safe driving practices through regular outreach programs; also, adequate funding and maintenance of road infrastructure by the state and local governments are recommended.

**Keywords:** Ado-Ekiti; Geographic Information System; Hotspots; Nigeria; Road Accidents.

## INTRODUCTION

Although transportation has liberated man and made mankind more mobile, the increasing reliance on vehicular movement has conferred great facilities on man and human activities. The greatest culprit of all the modes of transport is road transportation, of which road hazards resulting in accidents; and accident is the most disturbing repercussion of its (road transportation) use (Folorunso et'al 2022).

The principal objective of transportation is to bridge the gap created in space by the friction of distance. However, in its attempt to overcome distance through the delivery of goods, services and people from one location to another, there are associated problems resulting from transportation activities (Folorunso *et al.*, 2022).

The most important transport problems are often related to urban areas and take place when transport systems, for a variety of reasons, cannot satisfy the numerous requirements of urban mobility. Some of the common urban transport problems are traffic congestion and delays, road traffic accidents, air and noise pollution, and indiscriminate parking, among others (Rodrigue, Comtois and Slack, 2016). Notable among the urban transport problems is road traffic accidents. This is because the majority of transportation casualties in both developed and developing countries of the world can be attributed to traffic accidents (Naboureh, Feizizadeh, Naboureh, Bian, Blaschke, Ghorbanzadeh and Moharrami, 2019).

Despite the prevalence of road hazards in Ado-Ekiti, Ekiti State, Nigeria, there is a lack of comprehensive mitigation strategies to address these issues. Globally, accidents resulting from road hazards are the leading cause of injury-related deaths. injuries and deaths resulting from road hazards are on the rise and Nigeria's third-leading cause of overall deaths, the leading cause of trauma-related deaths and the most common cause of disability (Onyemaechi and Ofoma, 2016).

Indeed, news of road traffic accidents in Nigeria no longer stirs any surprise. What may be shocking, however, is the magnitude of the fatality. Daily, Nigerian Newspapers carry news of road traffic accidents that are considered significant only in severity. Thus, the continuing high rate of road accidents arising from road hazards and the unnecessary consequential waste of lives and properties is of great concern. The road hazards in Ado-Ekiti, Ekiti state, Nigeria, have become a significant concern for the safety and well-being of the residents and commuters. The frequent occurrence of road accidents, traffic congestion, loss of lives and damage to vehicles highlight the urgent need for a comprehensive analysis of road hazard hotspots. It is in this light that this study aims to identify and analyze the hotspots where road hazards are most prevalent and propose effective mitigation strategies to improve road safety in the area. Ultimately, the study aims to contribute to the improvement of road safety and reduce the occurrence of accidents and traffic congestion in Ado-Ekiti, thereby enhancing the overall quality of life for residents and visitors alike. By identifying the specific locations where these hazards are most concentrated, the study intends to provide insights into the underlying causes and contributing factors. This paper, therefore, identifies and map out road hazard hotspots using the Geographical Information System (GIS); analyze the causes; contributory factors and assess the impact of road hazards on users.

**Theoretical Frameworl and Review of Relevant Literature:** The underpinning theories and review of relevant literature are as presented in the following sections:

**Theoretical Frameworks:**

**The Theory of Road Safety*:*** Road safety has been defined as the degree of protection of participants in the transport process from road accidents and their consequences (Irina, 2021). The problem of ensuring road safety was developed on the initiative of the international community since the end of the 19th century, when the first fatal road accident occurred. the process of ensuring road safety consists of activities aimed at preventing the causes of road accidents, reducing the severity of their consequences. The wording of the above terms is fixed in the Federal Law of the Russian Federation "On Road Safety". Currently, the system for preventing road accidents and injuries is based on the assessment of the effectiveness of the measures carried out, mainly in the engineering and technical direction (Figure 1).

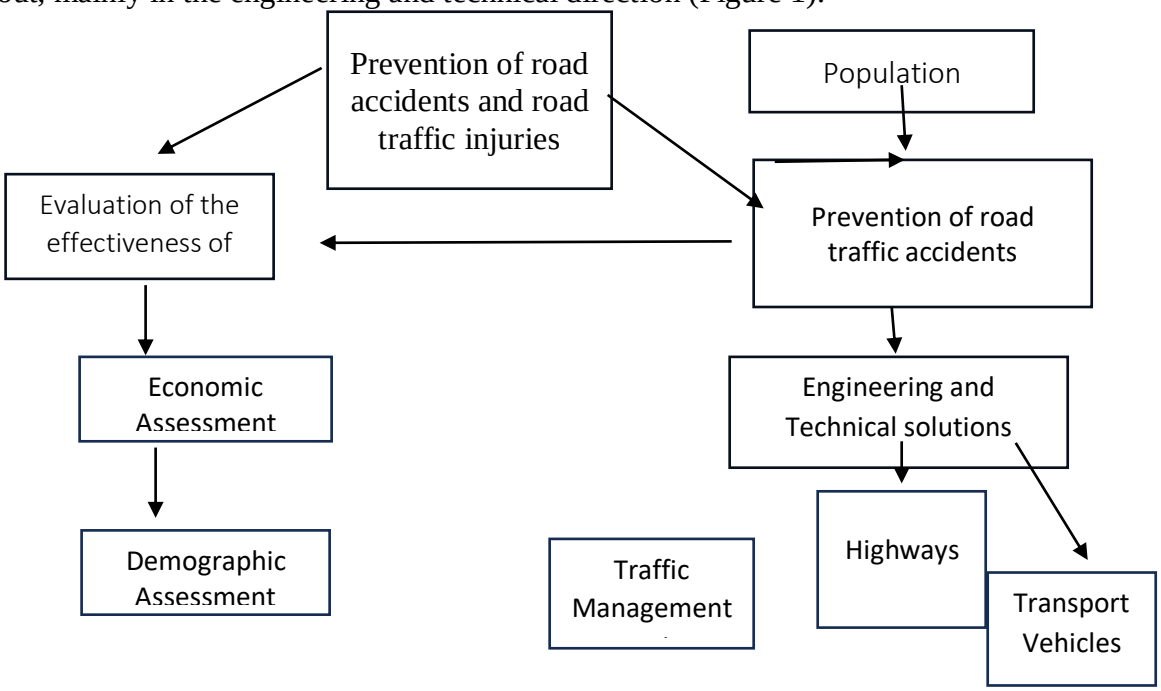


**Figure 1: Modern understanding of the road accident prevention systemAdapted from Irina (2021)**

**The Concept of Hotspots:**

A hotspot refers to a location along the road that is considered high-risk for vehicle collisions. Folorunso (2022) presented a conceptual meaning of a hotspot road section as any section with more expected accidents than other corresponding sections due to peculiar hazard factors prevalent in the section. Folorunso (2022) further outlined seven criteria of a modern hotspot identification method as: (a) identification of hazardous road locations from the population of sites, (b) avoidance of the sliding window method in hazardous road location identification, (c) use of the empirical Bayes (EB) method of hazardous road location identification based on the expected number of accidents at a particular site, (d) in a population of sites, hazardous road locations should be identified as the upper limit of the distribution estimation, (e) a short period (3–5 years) of data is appropriate for the identification of hazardous locations and the development of an accident prediction model, (f) on the condition that the estimates of the expected number of accidents by severity for a particular site can be determined, accident severity can be taken into account when determining hazardous road locations, and (g) particular types of accidents can be looked into when determining hazardous road locations, on the condition that estimates of the expected number of accidents of the specific type can be acquired for the particular site.

Hotspot programs are planned to reduce the collision risk in areas by improving the physical conditions or management. The hotspot is the number of personal injury accidents occurring within a 100 m grid square or 100 m length in three years in a particular road class. Therefore, the area is deemed a high-risk site if 20 accidents are recorded over three years on a 100 m length of road (Kowtanapanich, 2016). There are four criteria that a definition of hotspot location must satisfy: (a) random fluctuations in the number of accidents should be controlled, (b) factors responsible for having an impact on road safety should be considered, (c) sites with an overestimation of fatal and severe injury accidents should be identified, and (d) locations at which the local hazard factor associated with road design and traffic control made a considerable contribution to accident occurrences should be determined. These highway network spots are targeted as an all-inclusive safety program by traffic officials (Folorunso, 2022).

## LITERATURE REVIEW:

Road traffic deaths have risen from approximately 999, 000 in 1990 to just over 1.9 million in 2023 (WHO, 2023). Low-income and middle-income countries account for the majority of this increase. Although the number of road traffic injuries has continued to rise in the world as a whole, time series analysis reveals that road traffic fatalities and mortality rates show clear differences in the pattern of growth between high-income countries, on the one hand, and low-income and middle-income countries on the other (FRSC, 2015).

In general, since the 1960s and 1970s, there has been a decrease in the numbers and rates of fatalities in high-income countries such as Australia, Canada, Germany, the Netherlands, Sweden, the United Kingdom (UK) and the United States of America (WHO, 2004). At the same time, there has been a pronounced rise in numbers and rates in many low-income and middle-income countries. The reductions in road traffic fatalities in high-income countries are attributed largely to the implementation of a wide range of road safety actions, including seat-belt use, vehicle crash fortification, traffic-calming interventions and traffic law enforcement (FRSC, 2015).

However, the reduction in the reported statistics for road traffic injury does not necessarily mean an improvement in road safety for everyone. Every year the lives of approximately 1.19 million people are cut short as a result of a road traffic crash. Between 20 and 50 million more people suffer non-fatal injuries, with many incurring a disability. Road traffic injuries cause considerable economic losses to individuals, their families, and to nations as a whole. These losses arise from the cost of treatment as well as lost productivity for those killed or disabled by their injuries, and for family members who need to take time off work or school to care for the injured. Road traffic crashes cost most countries 3% of their gross domestic product (WHO, 2023).

The trend of road hazards in Nigeria has been characterized by a complex interplay of increasing road traffic accidents (RTAs), high fatality rates, and various contributing factors (Vitus, 2014). Despite some reports indicating a decline in certain accident parameters, the overall situation remains alarming. Nigeria is ranked

among the countries with the highest rates of road traffic fatalities globally (Awoniyi et'al 2021). Nigeria accounts for approximately one in every four road accident deaths in Africa, with an estimated 33.7 deaths per 100,000 population annually. The country has been noted for having 1042 deaths per 100,000 vehicles, which is significantly higher than rates in the United States and the United Kingdom (Awoniyi et'al, 2021).

A study by Awoniyi et'al (2021) indicated significant increases in road traffic injuries, casualties, and fatalities by 74.7%, 61.2%, and 9.6%, respectively. The leading causes of these accidents were identified as speed violations, loss of control, and dangerous driving. Human error is a major contributor, accounting for about 90% of accidents. This includes issues such as driver fatigue, poor knowledge of road signs, excessive speeding, and drug abuse. The state of road infrastructure in Nigeria is a critical factor. Many roads are in disrepair, and the increase in vehicular traffic has not been matched by adequate road construction or maintenance. The reliance on old and unroadworthy vehicles exacerbates the problem, as many vehicles on the roads do not meet safety standards (Vitus, 2014).

The economic ramifications of road hazards are profound. In developing countries, road traffic accidents can account for nearly 1.0% of the Gross National Product (GNP), which represents a significant financial loss for economies that can ill afford such expenditures (WHO, 2010). For instance, Nigeria, with its high vehicle population and extensive road network, suffers considerable economic losses due to road traffic accidents, exacerbated by poor road conditions and inadequate infrastructure (Federal Road Safety Corps-FRSC, 2017). The costs associated with road traffic injuries include medical expenses, loss of productivity, and the economic impact on families of victims. These factors collectively hinder economic development and strain public health systems.

Road hazards significantly affect the safety of road users. A study by Budzynski *et al.* (2017) highlighted that roadside hazards, such as trees, barriers, and utility poles, contribute to severe accidents, particularly in run-off-road incidents. The severity of these accidents is often linked to poor road design and inadequate safety measures, leading to a higher likelihood of fatal outcomes when vehicles collide with solid obstacles. Globally, road traffic injuries are a leading cause of death, particularly among vulnerable populations like pedestrians and cyclists. The World Health Organization (WHO) (2013) reports that approximately 1.19 million people die annually from road traffic crashes, with low- and middle-income countries bearing the brunt of these fatalities. The economic burden of road traffic injuries is substantial, costing countries about 3% of their annual GDP, alongside the human suffering caused by injuries and fatalities.

WHO (2013), noted that environmental factors also play a crucial role in road safety; for instance, the presence of roadside trees, while beneficial for aesthetics and ecology, can pose significant hazards if not managed properly. Efforts to enhance road safety often conflict with environmental preservation, as removing trees or altering landscapes can lead to ecological degradation. A balanced approach is necessary to ensure both road user safety and environmental protection, suggesting the need for innovative safety measures that do not compromise ecological integrity.

Nigeria recorded her first traffic accident in Lagos in 1906 (Ogunsanya, 2004). For more than half a century thereafter, accident rates in the country remained low due largely to low vehicular population (Ogunsanya, 2004). But from the 1970s following remarkable improvements in the economic prosperity in the country arising from the oil boom, the magnitude of the accident problem increased. According to Ogunsanya (2002), the period witnessed a substantial increase in private vehicle ownership (motor car fleet was reported to have increased by 183% between 1978 and 1987.

Despite integrated efforts towards reducing fatal road accidents, Nigeria still remains one of the worst hit countries. With a human population of over 200 million, a high level of vehicular population estimated at over 7.6million, a total road length of about 194,000 kilometers (comprising 34,120 km of federal, 30,500 km of state, and129,580 km of local roads), the country has suffered severe losses to fatal car accidents (FRSC, 2015).

Odusola *et al.* (2023), in their study revealed that incidences of road traffic crashes were highest across peak commuting hours (07:00-12:59 and 13:00-18:59), rainy season and harmattan (foggy) months, in densely

populated cities of developing nations. In Poland, Budzynski *et al.* (2017) noted that the main factors that influence the risk of being involved in road crashes include historic developments, road class, length and element of carriageway, hazardous elements at the edge of carriageway (mainly trees), safety measures in place or lack of safety measures. Onyemaechi and Ofoma (2016) posited that there is a need to view road traffic accidents as an issue of urgent national importance that needs urgent attention aimed at reducing the health, social, and economic impacts. He concluded that policymakers at the various levels of government need to recognize the growing problem of road accidents as a public health crisis and design appropriate policy responses that will be backed up with meticulous implementation. Wei *et al*. (2022) noted that the driver is more likely to be involved in collisions in covert hazard scenarios than in overt hazard scenarios. Drivers' perception of hazard urgency is reflected in driving behavior. Road traffic death rates are highest in the WHO African Region and lowest in the European Region. In 2019, the global incidence of road traffic injuries reached 103.2 million. The highest accident rates were found in those aged 20–24 years old globally. Cyclist injuries were the leading type of road injuries (34%), though pedestrian and motor vehicle accidents were the leading causes of death (37.4%, 37.6%) and disability-adjusted life years (DALYs) (35.7%, 32.3%), respectively (WHO, 2023).

Road accidents can be prevented using technological tools; while the most prevalent challenges of traffic officials include how to enforce preventive measures and provisions to maximize traffic safety (Khan *et al.,* 2021). The introduction of Information Communication Technology (ICT) into road traffic monitoring not only improves the efficiency of human road traffic monitors but also significantly enhances the safety of road users. The use of Intelligent Transportation Systems (ITS) enables various users to be better informed and make safer, more coordinated, and smarter use of transport networks, thereby ensuring the safety of all road users (Afolayan et'al, 2022).

Also, the use of Variable Message Signs (VMS) is a system which displays information that informs, warns, and guides motorists on highways and expressways. The system provides highly visible and concise information to drivers, which keeps them better informed, thereby helping to reduce traffic congestion and journey times while lowering pollution levels from queuing traffic (Ekwonwune, Ngozi and Eberechi, 2018).

The Traffic Light Control System (TLCS) is another technological innovation that uses traffic light placed on a road intersection or pedestrian crossing to indicate when it is safe to drive, ride or walk, using a universal color code (usually red, yellow and green). The provision of the TLCS by governments in developing nations, has greatly enhanced the safety and efficiency of transportation (Huang, 2006). The efficiency and effectiveness of the TLCS can be complemented by the use of Speed cameras which are used to monitor speed and record a car's number plate (Afolayan et'al, 2022). In addition, Afolayan et'al (2022) noted that video surveillance using Close Circuit Television (CCTV) is explosively popular for recording traffic patterns for future study and observation or monitoring traffic and issuing tickets for moving violations. The Geographic Information System is another technological tool capable of real-time generation of accident hotspots maps from a well-designed accident database and produce high accident rankings based on the total accident rates (Li, 2006).

## DATA AND METHODS:

**The Study Area:** Ado-Ekiti is the capital city of Ekiti State in southwestern Nigeria. It is located on latitude 7.6239° N and longitude 5.2209° E. Ado-Ekiti is situated on an undulating terrain, with hills and valleys scattered across the landscape. The city is part of the Ekiti Hills, which form a significant portion of southwestern Nigeria's relief features.

Since the creation of Ekiti State in 1996, the city has experienced rapid urbanization and significant development. Ado-Ekiti has witnessed considerable growth in terms of infrastructure development, population expansion, and economic activities. Ado-Ekiti has become a major hub for commerce, education, and governance in the state. Its strategic location and improved transportation network have contributed to its rapid urbanization. Economic activities in Ado-Ekiti are diverse and varied. Agriculture plays a significant role, with crops such as cocoa, yam, cassava, and maize being major contributors to the local economy. The city is also known for its vibrant textile and clothing industry, with many small-scale businesses engaged in the production and sale of fabrics and tailored outfits. Additionally, Ado-Ekiti has a growing service sector, with banking,

telecommunications, and healthcare being prominent. The presence of various financial institutions, telecommunications companies, and medical facilities has attracted investments and facilitated employment opportunities in the city.

In Ado-Ekiti, motorcycle (popularly known as *Okada*) is a widely accepted means of mobility, especially in areas where taxi cabs are not readily available. The rapid urban sprawl of the city has made it increasingly difficult for motor vehicles to cover all areas, making motorcycles a popular choice for urban mobility. The national, regional and local setting of Ado-Ekiti is as shown in Figure 1.

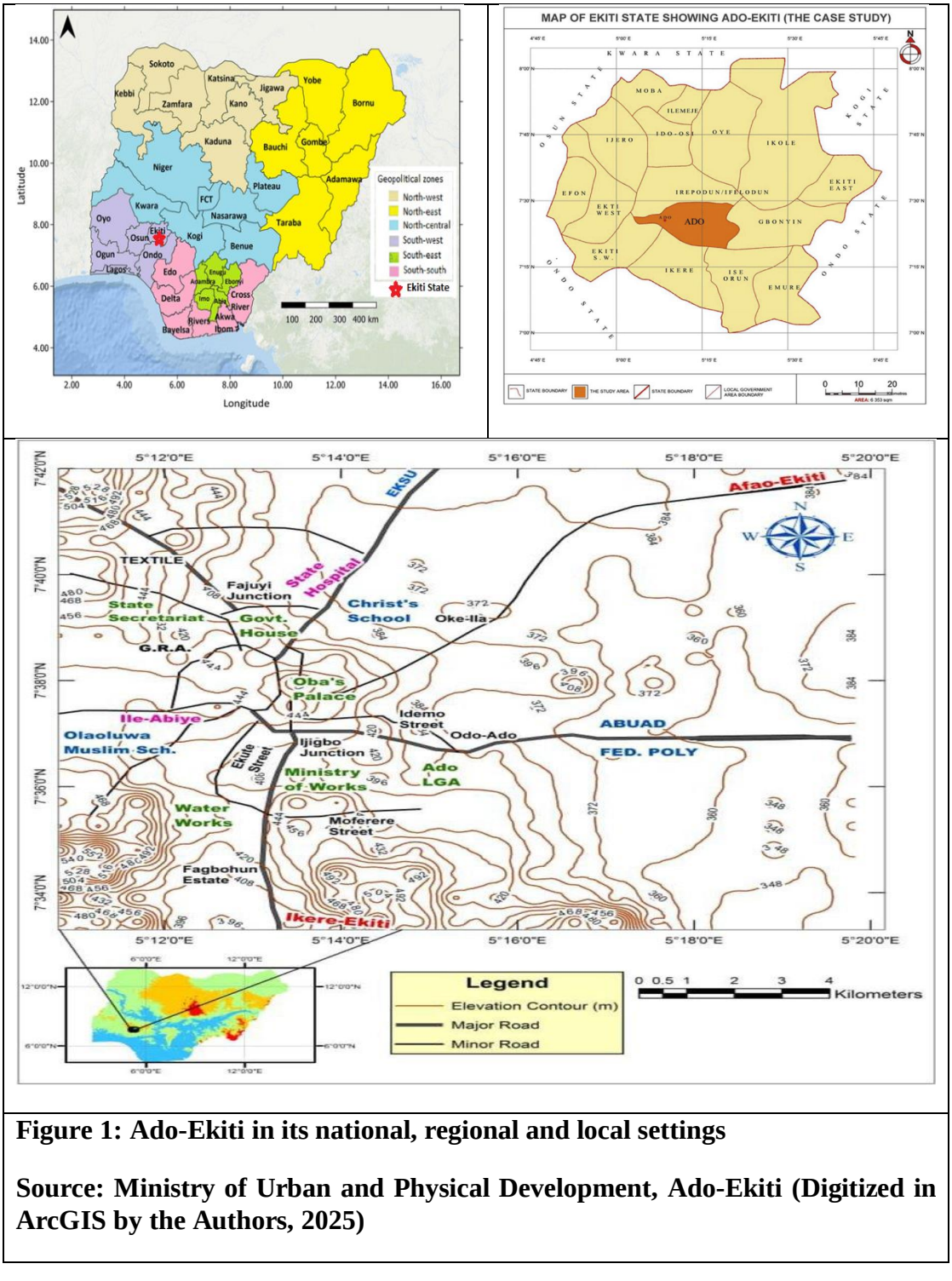


**Figure 1: Ado-Ekiti in its national, regional and local settings**

**Source: Ministry of Urban and Physical Development, Ado-Ekiti (Digitized in ArcGIS by the Authors, 2025)**

**Methods:** Both the primary and secondary data sources were utilized in this study. The primary data were collected with the use of a structured questionnaire and Interview Guide (IG). The structured questionnaire, consisting both closed and open-ended questions, allowing for the collection of quantitative and qualitative data respectively were utilized to elicit firsthand information, from residents, on road hazards encountered,

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awareness of mitigation strategies, and suggestions for improvement. The Observation technique was also adopted at different times of the day, to capture variations in traffic flow and behavior, traffic volume, and speed at various locations, and to understand how these factors contributed to road hazards. A physical survey of road conditions, traffic patterns, drivers' behavior, and accident hotspots in the study area were conducted with the digital camera to take photographs of interesting scenes. However, secondary data were collected from existing records from parastatals involved in accident documentation, such as the Federal Road Safety Corps (FRSC) and Ekiti State University Teaching Hospital (EKSUTH).

The sample size was determined using the Taro Yamane sample size determination formula:

**$n = N / (1 + N(e)^2)$.**

Where n = sample size

N= Population size (557,000)

e= error margin (0.05)

Using the desired level of confidence at 95.0%, with error margin of 5.0% and a population size of 557,000, the sample size was calculated thus:

$n = N/ (1+N) e^2$ (by formula)

$n= 557,000/ (1+557,000) *0.05^2$

n= 557,000/(557,001*0.0025)

n= 400.144

Therefore, sample size 'n' = 400

Hence, 400 questionnaires were randomly administered to respondents, including drivers, motorcyclists, pedestrians, police and road safety officers in the study area. Additionally, GIS tools were used to gather coordinates and map accident hotspots; while the Moran's Index analysis was used to analyze spatial patterns of road accidents.

## DATA ANALYSIS AND DISCUSSION OF RESULTS:

The results of empirical analysis and discussion on them are as presented in the following sections:

### Socio-Demographic Characteristics of Respondents

Table 1 shows the socio-demographic characteristics of respondents in the study area. The highest proportion of respondents (30.3%) were aged between 26 and 35 years. This is closely followed by 27.7% and 21.7% who fall within the age bracket of 18-25 and 36-45 years respectively. Generally, about 80.0% of respondents are between the age of 18 and 45 signifying a relatively active population who are the drivers of the nation's economy. Males constituted the majority of respondents, accounting for 63.7% of the total number of respondents. This phenomenon underscores the fact that the transport sector is driven by the male gender who are involved as taxi drivers, motorcycle (*Okada*) riders and mostly involved in traffic management. Moreover, most respondents (90.5%) are well educated who could read and write; hence understood the questions asked and gave answers which emphasizes the validity of data collected for this research. In addition, a greater percentage of the respondents (54.0%) were married, representing the dominant marital status group among the respondents. This demographic profile suggests that the data reflects the perceptions of a relatively young, educated, and predominantly male segment of the population, which may influence the awareness and attitudes toward road safety issues in Ado-Ekiti.

**Table 1: Socio-Demographic Characteristics of Respondents: (N=400)**

| Variable | Frequency | % |
|---|---|---|
| **Age** | | |
| 18-25 | 111 | 27.7 |
| 26-35 | 121 | 30.3 |
| 36-45 | 87 | 21.7 |
| 46-55 | 73 | 18.3 |
| >55 | 8 | 2.0 |
| **Gender** | | |
| Male | 255 | 63.7 |
| Female | 137 | 34.3 |
| **Education** | | |
| Post graduate | 120 | 30.0 |
| Tertiary | 150 | 37.5 |
| Secondary | 110 | 27.5 |
| Illiterate | 20 | 5.0 |
| **Marital Status** | | |
| Single | 164 | 41.0 |
| Married | 216 | 54.0 |
| Divorced/separated | 20 | 5.0 |

**Source: Field survey, 2025**

However, the predominance of young (18-45 years), educated (95.0%) male (63.7%) aligns with studies highlighting the role of demographic factors in road safety perceptions. It is on record that educational attainment influences compliance with safety measures; but without compliance culture due to training gaps and illiteracy (Aliyu *et al.* 2024).

**The Moran's Index Analysis:** The Moran's I statistical measure was used to quantify spatial autocorrelation of accident hotspots within the study area describing the extent to which the values of a variable at nearby locations are correlated. In this study, the Moran's I for accident hotspots analysis, shows z-scores and p-values to test the statistical significance of the observed autocorrelation; helping to determine if accident hotspots are clustered, dispersed or randomly distributed within the study area. The presence and strength of the analysis which ranges from -1 to +1 suggesting strong positive spatial autocorrelation (values close to +1), negative or weak spatial autocorrelation (values close to -1) and random spatial distribution for (values close to zero (0)) was adopted to arrive at final conclusion of whether accident hotspots are real, unreal or happens by chance respectively. The capability of Moran's I in analyzing spatial patterns to detect whether data points (accident hotspots) exhibit clustering, dispersion or randomness was relied upon. Therefore, Figures 3-7 show accident hotspots and the accompanying Moran's I analysis respectively in sections 4.2.2 to 4.2.6.

**Location of Accident Hotspots in Ado-Ekiti:** The pattern of road accident hotspots in the study area is as depicted in Figure 2. The identified accident hotspots include: Adebayo, Bank Road, Fajuyi, Oke-Oriomi, Oja Bisi, Okesa, Ojumose, Post Office, Adebayo and NURTW Park among others. The spatial spread analysis of taxi accidents within the 112 to 126 km² area, particularly along the Ojumose to Post Office corridor, reveals a concentration of high accident density, suggesting that this zone experiences more frequent taxi-related accidents. In contrast, the Bank Road, Fajuyi, and Basiri areas exhibit a lower incidence of such accidents, indicating spatial variation in risk levels across the city. However, despite these apparent hotspots, the Moran's I spatial autocorrelation analysis yielded a Z-score of 0.4, which is statistically insignificant and suggests that

the overall pattern of road accidents is not significantly different from a random distribution. This means that, while there are visually identifiable high-accident zones, the distribution of accidents across the study area does not exhibit strong spatial clustering or dispersion. The implications point to the need for localized rather than area-wide interventions, as the randomness of the pattern may stem from variable traffic behavior, infrastructure inconsistencies, or dynamic urban activity that is not spatially uniform.

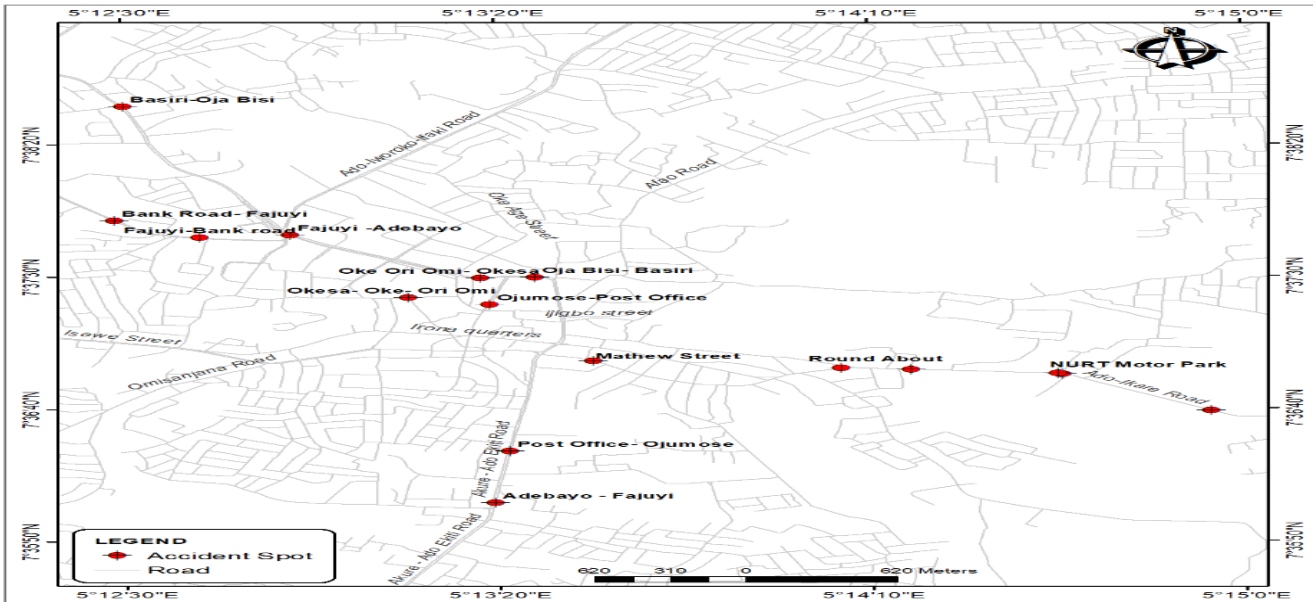
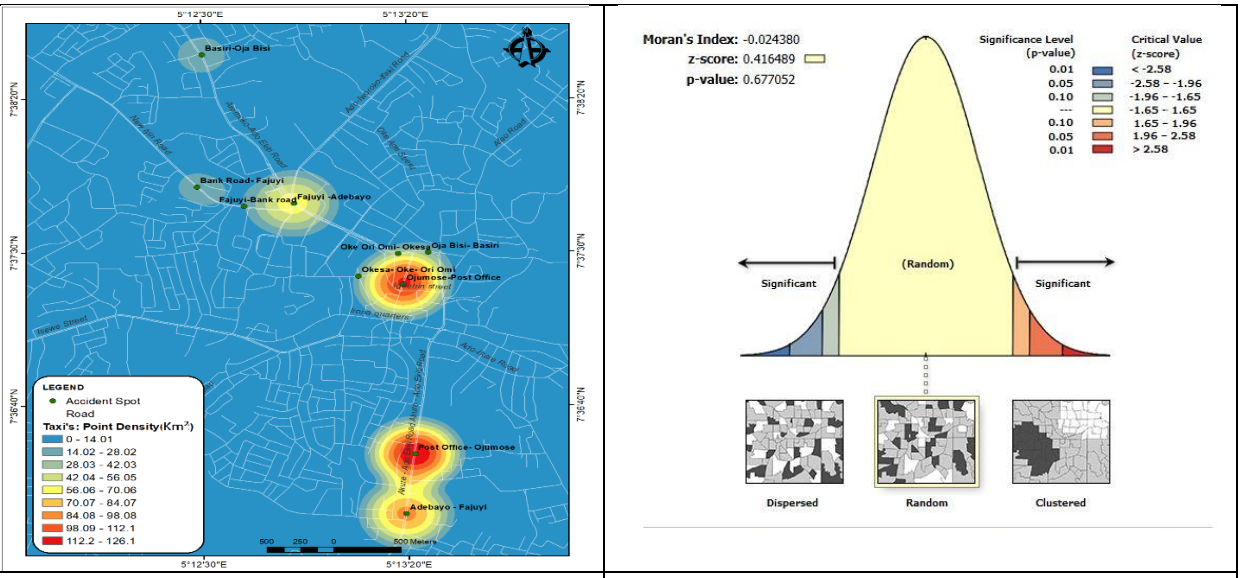



**Figure 2: Accident Hotspots in Ado-Ekiti**

**Source: Authors' Fieldwork, 2025**

**Location of Accident Hotspots for Private Cars**: Figure 3 shows accident hotspots for private cars in the study area. Figure 3 reveals that the distribution of road accidents is random, with a Moran's I Z-score of -0.4, indicating no significant spatial clustering. Although accidents occur across most parts of the study area, the Ojumose /Post Office Road Lane and the Basiri area show only a moderate frequency of accidents. This suggests that while road accidents are generally widespread and randomly distributed, these two areas experience slightly lower but still notable accident levels, highlighting the need for localized safety measures.



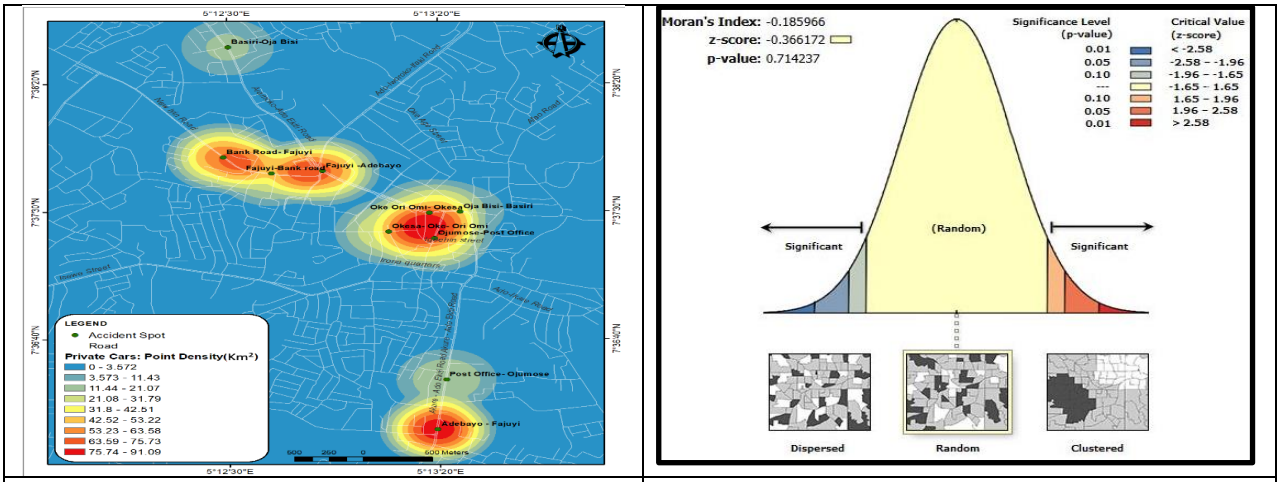

**(a) GIS Analysis for Private Cars Accident Hotspots** | **(b) Moran's Index Autocorrelation analysis**

**Figure 3: Accident Hotspots and Moran Index analysis for Private Cars in Ado-Ekiti**

**Source: Authors' Fieldwork, 2025**

**Location of Accident Hotspots for Taxis in Ado-Ekiti:**

Figure 4 shows the spatial analysis of taxi accidents within the 112 to 126 km² area of the city. Spatial analysis along the Ojumose to Post Office corridor, reveals a concentration of high accident density, suggesting that this zone experiences more frequent taxi-related incidents. In contrast, the Bank Road, Fajuyi, and Basiri areas exhibit a lower incidence of such accidents, indicating spatial variation in risk levels across the city. However, despite these apparent hotspots, the Moran's I spatial autocorrelation analysis yielded a Z-score of 0.426, which is statistically insignificant and suggests that the overall pattern of taxi accidents is not significantly different from a random distribution. This means that, while there are visually identifiable high-accident zones, the distribution of accidents across the study area does not exhibit strong spatial clustering or dispersion when evaluated statistically. The implications point to the need for localized rather than area-wide interventions, as the randomness of the pattern may stem from variable traffic behavior, infrastructure inconsistencies, or dynamic urban activity that is not spatially uniform.

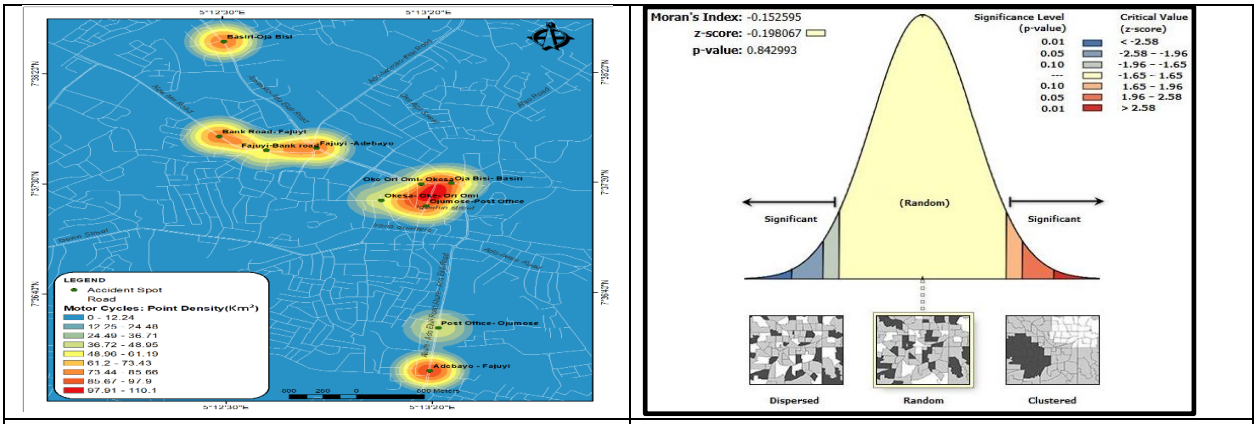



**(a) GIS Analysis for Taxi Accident Hotspots** | **(b) Moran's Index Autocorrelation analysis**

**Figure 4: Accident Hotspots and Moran Index analysis for Taxis in Ado-Ekiti**

**Source: Authors' Fieldwork, 2025**

**Accident Hotspots for Motorcycles in Ado-Ekiti:** Figure 5(a) shows GIS analysis of motorcycle accidents hotspots in Basiri, Bank Road, and Adebayo areas, with a high volume recorded along Post Office Road. This pattern shows that the overall distribution of accidents is random, indicating no significant spatial clustering across the study area. This suggests that while Post Office Road may require targeted safety interventions due to its high accident rate, motorcycle accidents generally occur unpredictably, highlighting the need for broad and adaptable safety measures.



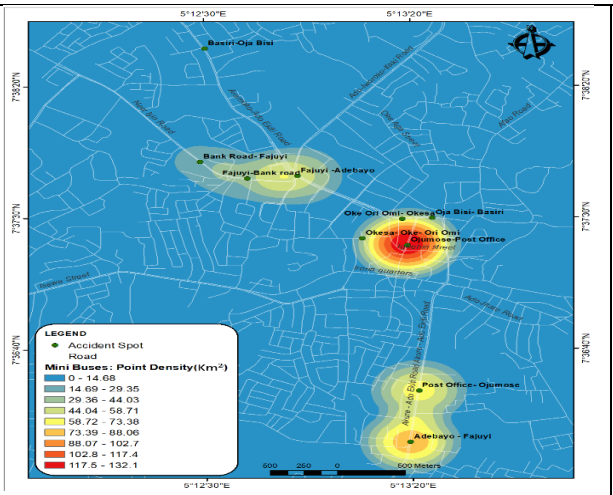

**(a) GIS Analysis for Motorcycles Accident Hotspots** | **(b) Moran's Index Autocorrelation analysis**

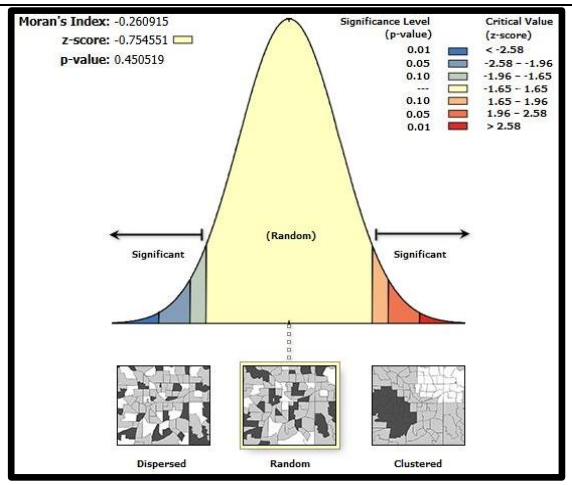
**Figure 5: Accident Hotspots and Moran Index analysis for Motorcycles in Ado-Ekiti**

**Source: Authors' Fieldwork, 2025**

However, Figure 5(b) shows the Moran's Index value of -0.152595 for motorcycles in the study area. This statistic suggests a weak negative spatial autocorrelation, indicating some dispersion in accident locations for motorcycles within the study area. This pattern shows that motorcycle accidents might be dispersed across the study area. Potentially, road conditions, traffic patterns and rider's Behaviour might contribute to this phenomenon.

**Accident Hotspots for Minibuses in Ado-Ekiti:** Mini buses accidents record a high density cluster on Post office area while other areas depict a close to medium density pattern (Figure 6(b)). Basiri happens to have a low density accident count of within an area of 0-14 km$^2$ coverage. The distribution of Mini buses road accident spot occurrence is random with a Moran's I value of -0.260915. this value suggests moderate negative spatial autocorrelation, indicating noticeable dispersion in accident locations for mini-buses within the study area. This pattern shows that mini-bus accidents are somewhat dispersed across the study area; hence, road conditions, traffic patterns, driver's behaviour or route characteristics might be the contributing factor.



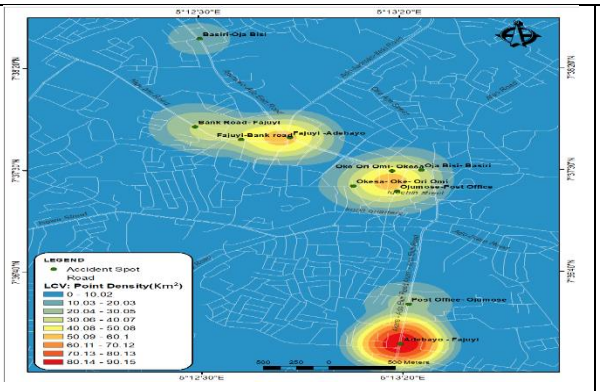

**(a) Accident Hotspots** | **(b) Moran's Index Autocorrelation analysis**

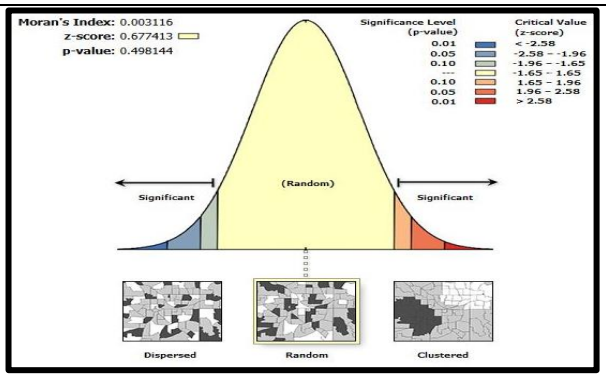
**Figure 6: Accident Hotspots and Moran Index analysis for Minibuses in Ado-Ekiti**

**Source: Authors' Fieldwork, 2025**

**Accident Hotspots for Light Commercial Vehicles (LCV) in Ado-Ekiti:**

Figure 7(a) shows a High density occurrence of Light Commercial Vehicle (LCV) accident along Adebayo – Fajuyi road. Fajuyi roundabout, Oke Ori-Omi to Okesa areas record a medium density fraction of LCV accidents. LCV accident locations are randomly distributed in the Moran's I Summary (Figure 7(b)).




**(a) LCV Accident Hotspots** | **(b) Moran's Index Autocorrelation analysis**

**Figure 7: Accident Hotspots and Moran Index analysis for Light Commercial Vehicles (LCV) in Ado-Ekiti**

**Source: Authors' Fieldwork, 2025**

From Figure 7(b), the Moran's Index show a spatial autocorrelation value of 0.003116. This value is very close to zero (0) suggesting random or weak spatial autocorrelation in accident hotspots for LCVs within the study area. The implication of this is that accidents might be randomly distributed across the study area; hence various factors might contribute to accidents making it challenging to identify specific accident hotspots.

Generally, Respondents demonstrated a strong awareness of road hazard hotspots, with over three-quarters agreeing that making information on these hotspots publicly available would enhance awareness and safety. There was consensus that the concentration of hazards in specific locations correlates with increased accidents and injuries, and that mapping these hotspots is crucial for prioritizing road improvement projects. However, there was some division regarding the prevalence of hazards in certain areas, indicating potential variability in local experiences or perceptions. The geospatial analysis revealed that accident patterns for different vehicle types (taxis, private cars, motorcycles, minibuses, light commercial vehicles, and heavy commercial vehicles) generally exhibited random spatial distributions, with some localized clusters of high accident density, particularly along major roads such as Post Office Road and Adebayo-Fajuyi road. This randomness suggests that while hotspots exist, accidents are not strictly confined to predictable clusters, highlighting the complexity of road safety challenges in the area.

Respondents' strong consensus on hotspot mapping reflects global best practices in prioritizing accident-prone zones. However, the observed randomness in accident clusters (e.g., Post Office Road) parallels Nigeria's broader challenges, where accident rates rise despite FRSC campaigns, as seen in the study by Cletus *et al.* (2025). The localized clusters align with Minna's FRSC data, where infrastructure upgrades and patrols reduced fatalities but struggled with inconsistent enforcement (Cletus *et al.,* 2025). Geospatial randomness underscores the need for dynamic, data-driven interventions rather than static hotspot identification.

**Causes of Road Accidents in Ado-Ekiti:** Table 2 shows respondents' opinion on the causes of road accidents in Ado-Ekiti.

**Table 2: Causes of Road Accidents in Ado-Ekiti**

| Variable | Responses | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Strongly Agree | | Agree | | Disagree | | Cannot Say | | Strongly Disagree | |
| | Freq | % | Freq | % | Freq | % | Freq | % | Freq | % |
| Poor Road Design | 144 | 36.0 | 172 | 43.1 | 63 | 15.8 | | 0 | 21 | 5.1 |
| Human Error | 91 | 22.8 | 201 | 50.2 | 21 | 5.1 | 13 | 3.2 | 74 | 18.7 |
| Poor Maintenance | 272 | 68.1 | 21 | 5.1 | 96 | 24.0 | 0 | 0 | 11 | 2.8 |
| Roadside Vegetation | 139 | 34.7 | 190 | 47.4 | 27 | 6.9 | 0 | 0 | 44 | 11.0 |
| Poor Traffic Management | 203 | 50.7 | 101 | 25.3 | 55 | 13.7 | 0 | 0 | 41 | 10.3 |

**Source: Field Survey, 2025**

The opinion of respondents on the causes of road accidents in the study area ranges from Poor Road Design, Human Error, Poor Road Maintenance, Uncontrolled Roadside Vegetation and Poor Traffic Management. For clarity and discussion purposes, "Strongly Agree" and "Agree" responses were combined as a positive response (Agree), while "Strongly Disagree" and "Disagree" responses were combined as a negative response (Disagree). Based on this, a larger percentage, 293 (73.2%) and 304 (76.0%) of the respondents agreed that poor road maintenance and inadequate traffic management/enforcement aggravate road accidents in Ado-Ekiti respectively. Moreover, 318 (79.1%) and 329 (82.1%) agreed that poor road design and uncontrolled roadside vegetation/encroachments are significant contributors to road hazards respectively. Conversely, fewer respondents disagreed with these statements, with disagreement levels generally ranging between 16.9% and 26.8%, indicating a broad consensus on the importance of infrastructure, human behavior, and institutional management as key factors influencing road safety in Ado-Ekiti. This broad consensus underscores the

multifaceted nature of road hazards in Ado-Ekiti, involving infrastructural deficiencies, environmental factors, and human behavior. The data from the Federal Road Safety Corps further corroborates these findings by highlighting speed violations, loss of control, brake failure, dangerous driving, wrongful overtaking, and tyre bursts as key accident causes. The identified factors i.e. inadequate traffic enforcement, poor infrastructure, and human behavior, agreed with the findings of (Cletus *et al.,* 2025) where visibility campaigns improved awareness, but inconsistent law enforcement limited impact.

**Impacts of road accidents on road users:** Figure 8 shows the respondents' opinion on the impact of road accidents on road users. About 177 (45.2%), strongly agreed that road hazards significantly increase the risk of accidents and injuries to road users; while 83 (20.75%), 66 (16.5%) and 74 (18.75) agree, disagree and strongly disagree respectively. Cumulatively, 65.0% agreed while 34.0% disagreed. This strong level of agreement reflects a high level of public awareness regarding the dangers associated with road hazards. The widespread recognition of these risks provides a valuable opportunity for authorities and stakeholders to implement targeted road safety interventions. Support from the community can help drive efforts such as improved road infrastructure, better signage, and stricter traffic enforcement to enhance safety for all road users in Ado-Ekiti.

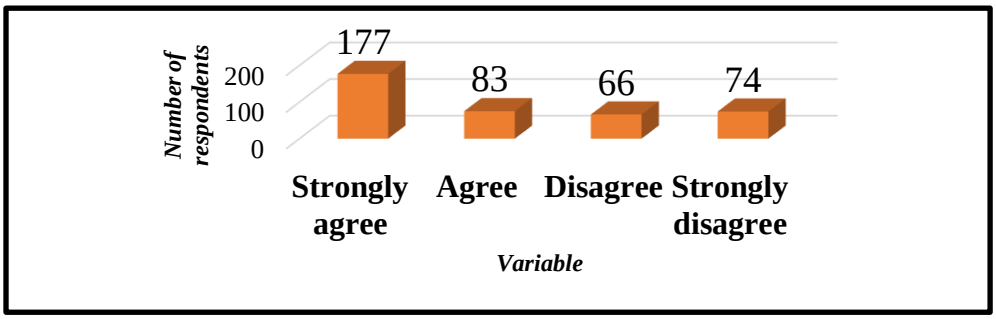



**Figure 8: Impacts of road accidents on road users**

**Source: Fieldwork, 2025**

**Gender Analysis of Road Traffic Collisions (RTC) between 2018 and 2024**

Figure 9 shows the gender analysis of people involved in RTC in 2018, 2019, 2020, 2021, 2022, 2023 and 1st Quarter 2024.The data for Figure 9 were collected from the database of the Federal Road Safety Corps (FRSC). The data covered the period from 2018 to the first quarter of 2024, showing gender analysis of people involved in Road Traffic Collisions (RTCs), casualties and fatalities in Ado-Ekiti.

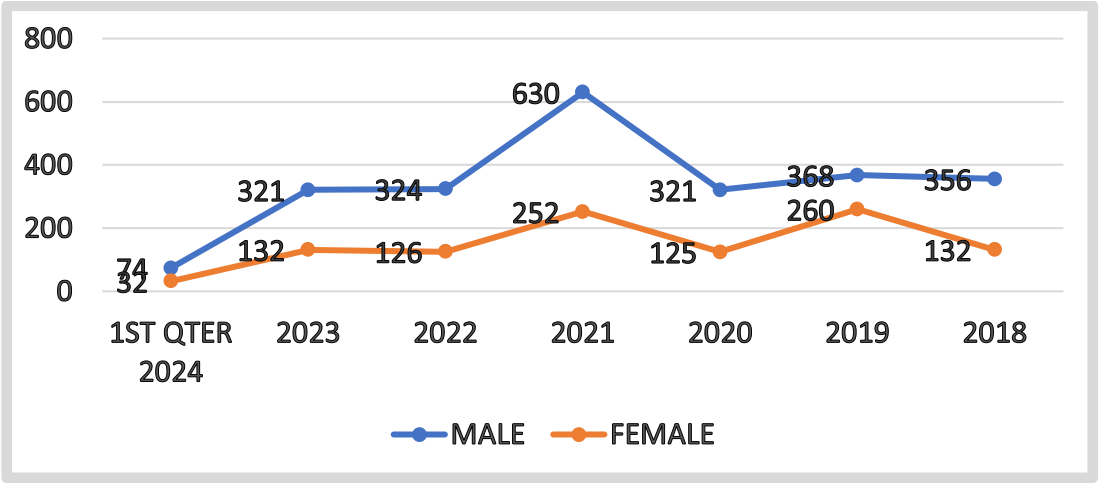



**Figure 9: Gender analysis of people involved in RTC in 2018, 2019, 2020, 2021, 2022, 2023 and 1st Quarter 2024**

**Source: Federal Road Safety Corps (FRSC), Ado Ekiti, 2025**

Notably, 2021 recorded the highest number of collisions for the female gender (252) and 630 for the male gender, indicating a peak in road safety challenges during that year, especially for the male gender who are mostly involved in driving and motorcycle riding. While some years (2023 and 2024) showed reductions in collisions and fatalities, the overall trend points to persistent and significant road safety issues that require sustained attention.

The 2021 peaks parallel national trends as noted by Eneh et al. (2025) where road quality degradation and vehicle safety lapses drive rising fatalities. Fluctuations in road traffic collision/accidents in Ado-Ekiti data in the study period mirror Nigeria's inconsistent progress, as FRSC interventions often lack sustained funding. The persistence of high casualties underscores systemic failures in infrastructure maintenance and policy implementation, as seen in South-Eastern Nigeria's deteriorating roads.

**Respondents' Opinion on reducing road hazards in Ado-Ekiti**

Table 3 presents respondents' recommendations for reducing road hazards in Ado-Ekiti. Summarily, a large majority, 340 (85.0%), of the respondents agreed that regular monitoring and evaluation of mitigation strategies are necessary to ensure their effectiveness. Additionally, 331 (82.7%) agreed that adequate funding should be allocated to address road hazards and improve road safety in Ado-Ekiti. Similarly, 330 (82.5%) agreed and emphasized the importance of collaboration between government agencies, road users, and road safety experts for implementing effective policies.

**Table 3: Respondents' Opinion on reducing road hazards in Ado-Ekiti**

**N=400**

| S/N | Variable | Strongly Agree | | Agree | | Strongly Disagree | | Disagree | |
|---|---|---|---|---|---|---|---|---|---|
| | | Freq | % | Freq | % | Freq | % | Freq | % |
| 1. | Adequate Funding | 174 | 43.5 | 157 | 39.2 | 48 | 12.0 | 21 | 5.3 |
| 2. | Regular Monitoring | 176 | 44.0 | 164 | 41.0 | 5 | 1.3 | 55 | 13.7 |
| 3. | Collaboration | 245 | 61.3 | 85 | 21.2 | 54 | 13.5 | 16 | 4.0 |
| 4. | Use of Planning Data | 115 | 28.7 | 203 | 50.8 | 36 | 9.0 | 46 | 11.5 |
| 5. | Stricter Enforcement | 187 | 46.7 | 124 | 31.0 | 48 | 12.0 | 41 | 10.3 |

**Source: Authors' Fieldwork, 2025**

In addition, 318 (79.5%) of the respondents agreed that the findings of studies of this nature should be used to inform future planning and infrastructure projects in the city. Also, 311 (77.7%) supported implementing stricter enforcement of traffic laws and regulations as a necessary step to reduce road hazards in Ado-Ekiti.

On the other hand, a smaller portion of respondents expressed disagreement with these recommendations, with negative responses ranging between 14.9% and 22.3%. This indicates a strong consensus among the respondents on the key strategies needed to improve road safety in the city.

**Implication of Findings:** The findings of this research can connect with the real-world impact in the following ways (i) the demographic profile with a showed a relatively young, educated, and predominantly male segment of the population, which may influence the awareness and attitudes toward road safety issues in Ado-Ekiti; (ii) the concentration of hazards in specific locations correlates with increased accidents and injuries, and that mapping these hotspots using GIS is crucial for prioritizing road improvement projects; (iii) the randomness of

accidents for different vehicle types suggests that while hotspots exist, accidents are not strictly confined to predictable clusters, highlighting the complexity of road safety challenges in the study area; (iv) the identified negative impact of road hazards in the study area highlights the extensive social and economic consequences of road hazards beyond immediate safety concerns, emphasizing the need for comprehensive interventions; (v) the study's longitudinal data from 2018 to the first quarter of 2024 which shows a fluctuating pattern of road accidents points to persistent and significant road safety issues that require sustained attention; and finally, (vi) the persistence of high casualties in the study period underscores systemic failures in infrastructure maintenance and policy implementation.

## CONCLUSION AND RECOMMENDATIONS:

**Conclusion*:***

In this paper, the demographic profile of respondents reflects the perceptions of a relatively young, educated, and predominantly male segment of the population, which may influence the awareness and attitudes toward road safety issues in Ado-Ekiti. Also, the road hazard hotspots in Ado Ekiti were identified and analyzed using GIS mapping technique and the Moran's Index analytical tools, which discovered significant challenges with road hazard hotspots majorly in the core and peripheral areas of the city due to infrastructure decay and human error respectively.

Also, this paper identified key factors such as inadequate traffic management and enforcement; uncontrolled roadside vegetation and encroachments; poor road design and infrastructure; poor maintenance of roads/signage; and human error, such as reckless driving, as major causes of road accidents in the study area.

Adequate funding and regular monitoring by security agents topped the priority list of respondents' opinions at reducing road accidents in the study area. The male gender was mostly involved in RTCs due to their higher involvement in driving, riding and major business activities in the study area. Adaptive measures identified by respondents for addressing road hazards in the study area include: implementing traffic calming strategies; improving road signage and visibility, and promoting public education on road safety. These findings indicate strong public support for road safety initiatives, highlighting the need for policymakers to leverage this readiness in designing and implementing effective interventions.

**Recommendations*:***

This paper, canvasses for the provision of speed limit indicators, and functional streetlights in high-risk areas. Also, promotion of public awareness campaigns to educate road users on traffic rules, hazard zones, and safe driving practices through regular outreach programs are also recommended.

## REFERENCES:

1. Afolayan, A., Easa, S.M., Abiola, O.S., Alayaki, F.M., Folorunso, O. (2022). GIS-Based Spatial Analysis of Accident Hotspots: A Nigerian Case Study. Infrastructures, 7, 103.
2. Aliyu, M., Abdul-Rani, A. M., Noorhayati, S., & Mustapha, M. (2024). Road Safety Officers' Perceptions of Awareness and Compliance to Safety Measures among Oil and Gas Tanker Drivers in North-Central Nigeria: Implications for Sustainable Development Goals. Ianna Journal of Interdisciplinary Studies, 6(2), 131–145. Retrieved from https://iannajournalofinterdisciplinarystudies.com/index.php/1/article/view/288
3. Awoniyi, O., Hart, A., Argote-Aramendiz, K., Voskanyan, A., Sarin, R., Molloy, M. S., & Ciottone, G. R. (2021). Trend analysis on road traffic collision occurrence in Nigeria. Disaster Medicine and Public Health Preparedness, 16(4), 1517–1523.
4. Budzynski, M., Jamroz, K., & Antoniuk, M. (2017). Effect of the road environment on road safety in Poland. IOP Conference Series Materials Science and Engineering, 245, 042065.
5. Cletus U., Dennis, I.A., Timothy, N., Usman, M., & Idris, A. (2025). Assessing the Impact of Activities of the Federal Road Safety Corps in Alleviating Automobile Accidents in Minna, Niger State. Kashere Journal of Politics and International Relations 3(1): 219-231.

6. Ekwonwune, E. N., Ngozi, N. C. A., & Eberechi, O. O. (2018). ICT devices: Vital tools for enhancing road traffic monitoring. Communications and Network, 10(03), 43–50.
7. Federal Road Safety Corps (FRSC) (2015). Comprehensive Annual Financial Report. https://frsc.gov.ng/CAFR.pdf
8. Folorunsho, J.O., Atomode, T.I. and Uwandu, S.C. (2022). Relationship Between Rainfall and Road Traffic Accidents in Lokoja, Kogi State, Nigeria. Ethiopian Journal of Environmental Studies & Management 15(5): 557 – 572.
9. Huang, Y.-S. (2006). Design and Analysis of Urban Traffic Lights Using Timed Colour Petri Nets. Proceedings of the 2006 IEEE International Conference on Networking, Sensing and Control, Ft. Lauderdale, p. 23-25.
10. Irina I (2021). Conceptual foundations of the theory of road safety. MATEC Web of Conferences 341, 00007, 2021, Retrieved on 9th July, 2025, from: https://www.matec-conferences.org/articles/matecconf/pdf/2021/10/matecconf_itmts2021_00007.pdf
11. Khan, G., Qin, X., and Noyce, D.A. (2021). Spatial analysis of weather crash patterns in Wisconsin. In Proceedings of the 85th Annual Meeting of the Transportation Research Board, Washington, DC, USA, p. 22–26 January 2006; Available online: www.topslab.wisc.edu/ publications (accessed on 25 March 2024).
12. Li, P.P. (2006). Road accident models and safety measures for vulnerable road users. In Proceedings of the 22nd ARRB Conference Research into Practice, Canberra, Australia, 29 October–2 November 2006.
13. Naboureh, A., Feizizadeh, B., Naboureh, A., Bian, J., Blaschke, T., Ghorbanzadeh, O. and Moharrami, M. (2019). Tra□c Accident Spatial Simulation Modeling for Planning of Road Emergency Services. ISPRS Int. J. Geo-Inf., 8, 371
14. Odusola, A. O., Jeong, D., Malolan, C., Kim, D., Venkatraman, C., Kola-Korolo, O., Idris, O., Olaomi, O. O., and Nwariaku, F. E. (2023). Spatial and temporal analysis of road traffic crashes and ambulance responses in Lagos state, Nigeria. BMC Public Health, 23(1).
15. Onyemaechi, N and Ofoma, U.R. (2016). The public health threat of road traffic accidents in Nigeria: A call to action. Ann Med Health Sci Res; 6:199-204.
16. Rodrigue, J.P., Comtois, C., and Slack, B. (2016). The Geography of Transport Systems. 3rd ed., New York: Routledge, p. 411.
17. Vitus, N. (2014). Trends and patterns of fatal road accidents in Nigeria (2006-2014). [Research Report] IFRA-Nigeria Working Papers Series 35, IFRA-Nigeria, pp.1–45.
18. Wei, T., Zhu, T, Li C and Liu H. (2022). Analysis of hazard perception characteristics based on driving Behaviour considering overt and covert hazard scenarios. PLoS ONE 17(4): e0266126.
19. WHO (2023, December 13). Road traffic injuries. https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries
20. WHO (2013). Global Status Report on Road Safety. Geneva 27, Switzerland.
21. World Bank. (2023). Financing public infrastructure in Sub-Saharan Africa: patterns and emerging issues (Vol. 2 of 3): Summary (English)
22. WHO and World Bank (2004). World report on road traffic injury prevention, edited by Peden M., Scurfield R., Sleet D., Mohan D., Hyder A.A., Jarawan E. and Mathers C. Retrieved 28/05/2025 from: https://iris.who.int/bitstream/handle/10665/42871/9241562609.pdf