Impact of Road Infrastructure on Road Traffic in Nigeria

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Abstract

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Planning, designing, and constructing road facilities should always be done with the well-being and safety of motorists in mind. Regrettably, infrastructure has often been the cause of road accidents. These may be overcome through consideration of the effects of construction factors on the risk of accidents, thereby ensuring the best possible treatment of the elements for better results. This study aims at (1) studying and understanding road infrastructure and its relevance to accidents and (2) improving road safety levels by enhanced response measures. Here, secondary sources in the form of books and journals were critically analyzed to meet the above-stated research questions and objectives. In this regard, it was found that infrastructure elements play a significant role in the occurrence of traffic accidents. In the context of road architecture, conceptual planning, design, construction, and infrastructure improvement, countering and preventing such accidents should start with the known techniques of Road Safety Audit (RSA) and Road Safety Assessment (RSA). Road safety can be improved if the public authorities take all the responsibility of enacting safety protocols and policies, making sure that the rules are strictly implemented and standardized safety level assessment were carried out.

1. Introduction

Road safety is a global issue that must be taken seriously. According to 2015 data from the World Health Organization (WHO), from 2001 to 2013, the number of car accidents worldwide did not decrease but increased. The WHO also shows that more than approximately 1.2 million people lose their lives in road traffic crashes every year, especially those between the ages of 25 and 45. Some books suggest that road accidents mainly stem from the interaction between people, machines, roads, and the environment.

Roads are the cause of traffic accidents, and to mitigate the likelihood of vehicle accidents, all aspects of user safety must be taken into account in their design and construction. Too narrow or non-standard roads, sharp bends, steep inclines, steep slopes, surface damage, and poor road lighting are factors that lead to crashes.

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Paradoxically, the infrastructure of roads intended to assure safety and ease of use by the users can, in the same breath, cause traffic accidents. In-depth research is therefore needed to reduce traffic accidents caused by road architecture and understand the impact of various aspects of road architecture on road collisions to better handle road safety.

2. The Aims of the Research are:

- Understand and examine the impact of road infrastructure on traffic accidents.
- Provide better measures to increase the safety of infrastructure.

Major research questions were analyzed and discussed from academic journals and books containing academic articles and pertinent literature. This research will be objective in relation to any road. Careful analysis and discussion about the impacts of road infrastructure on traffic accidents will improve knowledge and understanding of the importance of proper road design and construction with safety considerations in mind to reduce the risk of traffic accidents.

The present paper is divided into three parts. First, the methodology explains how the paper will be carried out, including data sources and the review procedure. Second, the analysis of the impact of infrastructure on traffic accidents includes descriptions of efforts to increase user safety. Last but not least is the conclusion, which includes the key findings of the preceding discussion and analysis.

3. Methods of Research

Therefore, the basic motives of this study are two-fold: first, to study how the infrastructure affects traffic accidents, and then, to find the needful measures for improving traffic safety. The methodology used for this study is artifact analysis. This includes gathering, analyzing, and discussing secondary data from journal articles and other relevant literature. In this case, the analysis and discussion of the study are divided into three parts:

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- Infrastructure modularization into separate components.
- Exploring the impacts of road infrastructure on road traffic accidents.
- Discussing the steps needed to improve the safety of road infrastructure.

4. Analysis and Discussion

4.1 Infrastructure Features

Before considering the role of road infrastructure in road traffic accidents, it is necessary to break down road infrastructure into its component parts. Doing so makes a clearer discussion possible, given the fact that each component will contribute in a different manner to the danger posed by traffic accidents. The components of infrastructure to be explored include:

- Land transportation infrastructure, which incorporates everything that has to do with the road, from the pavement itself to the structures and equipment that were built to support traffic on those roads.

- Two basic principles that need to be made so that strong road infrastructure is arrived at are security and safety. Security means the implementation of engineering standards; safety involves the consideration of road surface conditions and geometric design.

They are mandated to follow the technical standards in some important areas if they are to be operationally viable:

- Road Geometry
- Pavement structures
- Complementary buildings
- Road components usage
- Traffic Management and Engineering
- Road equipment

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As a refinement of the above three divisions, this paper divides the components of road infrastructure into the following categories:

1. Road surface Conditions
2. Geometric Features (including lane width, horizontal and vertical curves)
3. Auxiliary infrastructure (such as sidewalks and bus bays)
4. Road equipment (including markings, signs, and lights)
5. Roadside hazards

The following section will discuss these five factors and their respective subcomponents to explain how they influence car accidents.

4.2 Geometric Features

Lane Width: All roads are designed with standard lane widths. For example, in the highway construction policy, the working width of the main road varies between 3.0 and 3.6 m. It is also usable in different types of road classes, with different lane widths, as well. Determining the elasticity bandwidth depends on the environment and economics. There is a commonly held opinion that the higher the rate of traffic accidents, the narrower a lane is. This is because, in wider lanes, there is space between cars, which gives way to the possibility of more maneuvering in an accident situation.

The study by Potts et al. on urban and suburban roads showed that lanes narrower than 3.6 meters had no increase in accidents. Thus, results indicate the necessity of flexibility on narrower lanes for the process of road design.

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Horizontal Curve: It refers to a section of a highway that allows the transition from one straight highway to another. Upon approaching the horizontal curve, the driver is subjected to centrifugal force, which calls for an appropriate reaction from the driver to enable them to transit safely and avoid accidents.

Research findings recorded 95,552 vehicle accidents in the horizontal sections of Southern Nigeria from 2019 to 2022. The Federal Road Safety Corps also underscored horizontal bends as contributing to accidents in urban roads, especially on two-lane undivided urban arterials. The most common types of traffic accidents reported in horizontal areas are run-offs and head-on collisions.

Several measures were undertaken to measure the affectation of horizontal curve characteristics on road traffic crashes. Results clearly show that the radius has a great impact on road traffic crashes, and so does length, adjourning curves, transition curves, and super-elevation, which are all also significant in relation to the occurrence of road traffic crashes.

Sound geometric planning and design are among the principal measures that can be taken to improve road user safety on the grounds of geometric issues. Hazardous geometric features on the roads should be rectified through existing plans and designs. Advanced warnings should be put in place at horizontal curves and should be integrated with effective road marking systems.

Vertical Curves: They provide smooth transitions between vertical tangents of various grades. They are usually parabolic in shape and take place wherever two distinct tangents meet. There are two major kinds of vertical curves: crash curves and sag curves. As far as road traffic accidents in Nigeria are concerned, statistics in numerous studies have statistically attributed the causes of such crashes to vertical curves.

Research that has tried to outline the Vertical curves-traffic accidents relationship have revealed geometric features like steep gradients and long runs of continuous descent as having important impacts on the rate of accidents. This is because vehicles of differing climbing abilities who co-use steep slopes affect the road's capacity levels and increase the risk of accidents. Besides, traffic accidents are found to be more common in the downhill direction of a vertical curve than in the uphill direction. Reasons may include long downhill stretches leading to brake overheating or loss of efficiency, requiring the setting of limits on longitudinal length.

Sharp crest and sag curves can also cause accidents due to reduced visibility and longer viewing distances, much the same as horizontal curves since visibility is limited at crest curves and an increased risk of crash occurs at sag curves because of their longer distances. The width of the road is also a very crucial geometric characteristic in affecting the safety of road users. In this respect, one should not plan and design very steep and long vertical road curves to increase the safety of road users using such segments.

4.3 Road Surface Condition

Road surface distress encompasses cracking, patching, potholes, surface deformation, and irregularities in curvature. This paper studies the impact of pavement distress on accident

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risks considering pavement surface damage cumulatively. Poor road conditions are a serious consideration, especially regarding traffic safety. Poor road surfaces characterized by huge potholes, large cracks, and discomfort at low speeds raise the risk of fatal accidents, especially at high-speed roads and due to the involvement of multiple and single vehicles.

Research works concerning the incidence of traffic accidents regarding road surface conditions have been carried out, and they reveal that road surface conditions significantly relate to traffic accident rates. Chan et al. and Li et al. recommendations insist that pavement surfaces have to be properly maintained to mitigate road crash rates. Therefore, it is important to ensure that roads are in an acceptable state, which ensures the safety and comfort of users on the road.

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4.4 Roadside Hazard

A stationary object in the roadside area that enhances the severity of crashes is called a roadside hazard. Examples include such fixed objects as sign supports, clusters of trees, and utility poles located along the roadway. The hazards greatly affect the severity of run-off-road traffic crashes since vehicles veering off the road may strike trees or other hazardous objects, increasing the level of fatalities.

Information from past research data, there have been long-term investigations to determine fatality rates and the role played by roadside hazards among crash victims. Generally, such studies find that the presence of hazards, such as trees, will increase the number of fatalities caused by road traffic crashes.

The measures recommended for this include the eradication, relocation, modification, or closure of hazards, as well as the concepts of clear zone ideas to ensure that the roadside environment is hazard-free and safe for driving.

4.5 Auxiliary infrastructure

Sidewalks: They are very important infrastructure. They provide a safe way for pedestrians to walk alongside other traffic. Broken sidewalks occur when a section of the sidewalk is below the standard of repair. It can be in the form of pitting, scaling, cracking, or blockages. In such a case, pedestrians are in danger as it forces them onto the road and jeopardizes their lives and others.

Earlier research has focused on pedestrian facilities that serve road user safety. A good pedestrian facility, if designed and maintained, assures safety for all users of the road.

Bus stops: They are integral parts of any transport system and serve as areas where buses take passengers who board and alight. Traditionally, two types of bus stops are common: curbside stops and bus bays. With regard to traffic safety, bus stops pose a high crash risk when buses use the lane space for regular traffic.

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In studies that have focused on these two kinds of bus stops several studies have focused on the effect of these two kinds of bus stops on the rate of accidents. Curbside stops result in long queues and delays due to the large size of buses. In addition, traffic conflicts arise from the tendency for vehicles on regular routes to circle around buses.

On the other hand, bus bays provide better separation in traffic flow, reducing conflicts between buses and other motor vehicles. According to some studies, bus bays are safer alternatives to curbside stops in areas where the rate of traffic is high. The risk of accidents is, therefore, reduced.

4.6 Road Equipment

Markings: Road marking consists of the signs on the roadway surface, longitudinal, transverse, slanting lines, and symbols that guide traffic flow and mark the traffic areas. Road markings play a crucial role in ensuring safety for road users, particularly when visibility is poor, such as at night or in the rain.

Driving in low visibility conditions might cause accidents but good road markings may give rise to safety for road users. Studies show that edge lines in curves increase safety by facilitating the driving of drivers in their lanes. Overall, research concludes that road markings increase driver comfort and line guiding, especially in situations of low visibility, like at night or during rain.

Signs: Traffic signs are those signs that use symbols, letters, numbers, or sentences, conveying warning, prohibition, order, or direction to road users. Similar to road markings, the signs contribute to road safety by providing warnings and guides regarding the condition of the road.

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The influence of signs on road safety, especially variable message signs, can impact vehicle speed in such a way as to minimize road accidents. Signs, especially warnings and speed restrictions, can successfully improve safety in a curved portion of the road because drivers are warned to reduce vehicle speed as they approach curves.

Implementing chevron signals actually turned out to be effective in effectively reducing vehicle speed in areas of curves. In addition, the utilization of herringbone patterns, chevron markings, and repeater arrow signs in curving areas helps keep the position of the vehicle within the lane.

Lights: They light up the street environment, most especially at night when visibility is poor. This means that street lights contribute towards the reduction of serious crashes on the roads. So much research has been conducted concerning the influence of street lighting on road traffic accidents., and they have consistently indicated that the occurrence of traffic accidents, especially severe ones, is more prevalent at night because visibility is poor.

Some of the studies have investigated how street lighting impacts traffic accidents and concluded that the occurrence of traffic accidents on straight roads, curved roads, and at intersections of roads inadequately lit is higher than on well-lit streets.

Road infrastructure has several strategies and initiatives in efforts to address traffic accidents.

A discussion of the impact of road infrastructure on accident risk shows that it has a significant impact on traffic accidents. This conclusion was also supported in the World Health Organization's report titled Global Status Report of Road Safety in 2015, and it was revealed that improvements in infrastructure are important for creating safe roads.

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The life cycle is planning, design, construction, operation and decommissioning. It is important to ensure the safety and comfort of road users at every point of the lifecycle of the road surface.

Road Furniture Safety Management (RFSM) is a road safety management program. RSFM—Road Safety Furniture Management is a system of procedures that supports decision-making at different levels of relevant road safety stakeholders and authorities. This approach allows for proactive steps in constructing new roads and reactive strategies to be used on the existing infrastructure of roads.

In general, RSFM provides numerous tools targeted at increasing road infrastructure safety. Prominent tools include Road Safety Audit, to be conducted in the periods of planning, design, construction, and pre-opening, along with Road Safety Inspection done on existing roads during maintenance or renewal procedures. According to Jamroz et al., Road Safety Audit can reduce the number of casualties by 10-25%, while Road Safety Inspection can perform reductions from 1 to 20%.

5. Conclusion

Improving traffic safety requires more than the aforementioned efforts. In the studies by Bener et al. in their paper, "Strategy to Improve Road Safety in Developing Countries," there is a difference in the approach the developed world and the developing world have in reducing road traffic crash numbers. In developed countries, there is a highly valued aspect of road safety, and such measures involve comprehensive, preventive, and intervention strategies that prevent road traffic crashes. This is closely related to close cooperation between the various involved stakeholders—traffic police, Federal Road Safety Corps, health authorities, law enforcers, and the agencies concerned with transportation. This revelation coincides with the World Health Organization's 2015 Decade of Action program on coordinated action to address road safety issues.

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The goal of the present study was to study two aspects:

1. The influence of the road infrastructure on accidents
2. Formulate strategies for road infrastructure and safety.

As a result of the research, the following summary can be drawn:

- In the assessment process, this study divided road furniture/infrastructures into their major elements and then analyzed the relationship between those elements and consequent crashes. Results would show that road geometry, condition of the road surface, roadside hazards, auxiliary buildings, and equipment played a significant role in traffic accidents. Road safety thus requires the construction of each component according to the standards of planning, with all safety factors taken into consideration.
- The life cycle of road infrastructure embraces a set of planning, design, construction, and operation stages, all of which require safety measures. With this in mind, a Road Safety Audit is useful in the planning, design, construction, and early operation

stages, a Road Safety Assessment is useful in existing roads. Studies suggest that with this approach, a possible reduction of 10-25% in road traffic crashes and 1-20% respectively is possible.

- The significance and government commitment toward overcoming traffic safety concerns should be paramount. Public authorities establish standardized safety designs, prescribe the necessary regulations, and lay down methods to assess and evaluate overall levels of safety achieved. Still, even with these efforts, they may be inadequate to address traffic safety concerns fully.

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