

The Influence of Road Infrastructure on Road Traffic Accidents in Ghana A Case Study of the Ashanti Region of Ghana

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Abstract

Road safety has become a global issue of concern and concrete effort needs to be adopted at the ground level to abate the thousands of lives being lost in road traffic accidents around the world. One of the important and cogent measures for subsidising road crashes fatalities is continuously improving and maintaining good shapes and conditions of our roads. The design of roads plays paramount role in terms of road safety.

This study provides strategies and measures that are concrete to tail off the problem through multifaceted methods which involve effective road engineering solutions at the design stage.

The purpose of the study was to assess road infrastructure situation in Ghana and provide effective measures to recede the problem.

The study seeks to measure how roads are maintained with frequent relaying of road surfaces and markings of road safety signs and also to assess the condition of pedestrian's footpaths and pedestrians crossing at intersection and measure availability of road signs and signals, pavement, and road lanes.

Cross sectional study design was used to collect data. Ashanti region of Ghana was used as a case study. Open and close ended questions and also focus group discussions were used to collect data from the respondents. The study participants were made up of road users (motor vehicle users and pedestrians), and stakeholders within road infrastructure management. The study participants were 217. The study found that, road infrastructure in the region is strongly associated with road traffic accidents in the region.

Keywords: Road Conditions, Road Traffic Accident, Road Traffic Safety, Pavement.

Introduction

Road infrastructure is considered as one of the principal contributory factors to road traffic accidents. Poorly-maintained roads cause half of the fatal auto accidents that happen each year in the United States. An 18-month study conducted by The Pacific Institute for Research and Evaluation examined information from the National Highway Traffic Safety Administration, Federal Motor Carrier Safety Administration and other government agencies and concluded that road problems like potholes and iced-over stretches of highway cause more than 42,000 deaths a year.

It is the government's job to maintain roads. In many cases, it is the government entity charged with maintaining the road where accidents took place. But there are also times when someone other than the government may decide to construct and maintain a road network.

Washington, January 9, 2018—A new World Bank study, funded by Bloomberg Philanthropies, finds that reducing road traffic deaths and injuries could result in substantial long-term income gains for low- and middle-income countries. The report, "The High Toll of Traffic Injuries: Unacceptable and Preventable," introduces a new global methodology to calculate the economic impact of road safety and analyses the cases of China, India, the Philippines, Tanzania and Thailand. While there is general recognition of road traffic injuries and fatalities, little is known about the link between road traffic injuries and economic growth. The new report quantifies how investments in road safety are also an investment in human capital. The study finds that countries that do not invest in road safety could miss out on anywhere between 7 and 22% in potential per capita GDP growth over a 24-year period. This requires policymakers to prioritize proven investments in road safety. The cost of inaction is more than 1.25 million deaths a year globally, diminished productivity and reduced growth prospects.

Road traffic fatalities disproportionately affect low- and middle-income countries, where 90% of global road deaths occur. Rising incomes in many developing countries have led to rapid motorization, while road safety management and regulations have not kept pace. According to the report, deaths and injuries from road traffic crashes affect medium- and long-term growth prospects by removing prime age adults from the work force and reducing productivity due to the burden of injuries. Using detailed data on deaths and economic indicators from 135 countries, the study estimates that, on average, a 10% reduction in road traffic deaths raises per capita real GDP by 3.6% over a 24-year horizon. In addition to the GDP gains from preventing death and injury, road safety interventions improve welfare benefits to the society. The World Bank study has quantified these gains for the five countries using a range of income and risk reduction scenarios. Measured in 2005 US dollars, the welfare gains range between \$5,000 to \$80,000 in Tanzania, and between \$850,000 to \$1.8 million in Thailand.

The above situation is not different in Ghana. General News of Wednesday, 23 January 2019, indicated that Ghana spends up to \$230 million every year treating injuries and traffic fatalities and over 230 million is lost annually to treat trauma cases in Ghana, and we also have figures that suggest that in a period of 1 year, we have over 5,000 reported fractures.

Data compiled by Motor Traffic and Transport Department (MTTD) of the Ghana Police Service had revealed that, the total number of commuters killed in road traffic accident in 2018 recorded a 12.76% jumped over the figure for 2017. This means persons killed rose from 2,076 in 2017 to a total of 2,341 in 2018.

Financial losses due to road traffic accidents are a great burden on the victims, their families, different countries and the world as a whole and especially to the low- and middle-income countries that bear the major burden due to RTA. These financial losses are preventable by reducing the number of accidents by taking care of the factors responsible for these accidents and this is the main intended purpose of this study.

On average, a 10% reduction in road traffic deaths could raise per capita real GDP by 3.6% over a 24-year horizon (A new World Bank study, January 9, 2018, Washington) of which Ghana is of no exception. The greatest share of mortality and long-term disability from road traffic crashes happen amongst the working-age population between 15 and 64 years old. (A new World Bank study, January 9, 2018, Washington). Therefore, reducing road traffic deaths and injuries in Ghana can boost income growth. The results of this study would help all stakeholders (policy makers) to review various traffic policies and management in a bid towards mitigating against traffic accidents.

According to WHO (2013), Africa has the world's highest death rate per population – that is, 24.1 per 100,000 of the population, even though data are not correctly reported. At least, road accident statistics in Ghana confirm the above statistics. It is estimated that road traffic accidents in Ghana have killed 46,284 persons between 1991 and 2018. (Data compiled by the Motor Traffic and Transport Department, 2018). Data compiled by the Motor Traffic and Transport Department (2018) of the Ghana Police Service shows that we are only in the middle of 2019 and figures already look frightening. The data compiled by MTTD indicates that one thousand two-hundred and fifty-two (2252) persons have died from road traffic accidents since January 2019. A breakdown of the figure means at least seven people die from road carnages a day.

Data compiled by the Motor Traffic and Transport Department (MMTD) of the Ghana Police Service shows a 3.3% increase in the number of commuters killed in road accidents between January and June 2019 compared to the same period in 2018. According to the data, the number of commuters killed rose from 1,212 in the first half of 2018 to 1,252 during the first six months of 2019.

Typically, it takes government a reasonable amount of time to discover poor road conditions and a reasonable amount of time to repair them. Governments generally discover dangerous road conditions in one of two ways:

- through individuals reporting a dangerous condition, and
- by conducting regular surveys of the roadways.

Condition of roads

1. Roads should be well maintained with frequent relaying of road surfaces and markings off road safety signs.

2. Provide proper footpaths for pedestrians and pedestrian crossings at intersections.
3. Provide separate lanes for slow-moving and fast-moving vehicles.
4. Roads and junctions should be wide and well-lit so that visibility is good.

Causes & effects of bad roads

Poor driving surfaces are often caused by a combination of seasonal and traffic conditions. In Ghana, we experience intense seasonal shifts. These changes in weather can cause hazards like slippery surfaces caused by rain and oil spots caused by our vehicles. Construction zones with uneven pavement are also a major cause of accidents.

How accidents are caused

Poorly maintained roadways cause accidents in a variety of ways, mostly due to the fact that they create an enormous hazard to drivers. In many instances, a driver may attempt to avoid a certain situation, like a pothole or pooling water which could cause a serious accident.

Some hazards include:

- Clear zone issues
- Confusing signage
- Inadequate signage
- Sudden driver manoeuvres

Types of bad road conditions

There are several types of bad driving situations which exist and should always be taken care of;

- Potholes: Severe accidents can occur when blacktop or asphalt are missing in large chunks from the road.
- Shoulder drop-off: A drop-off region can present a serious danger to drivers.
- Oil and chip: These are temporary fixes on roads before they are resurfaced. Oil and chip areas can become slippery when left for extended periods of time.
- Construction work zones: Lanes shift and uneven roads are some of the issues involved in construction areas.
- Slick roads: Slippery surfaces cause hydroplaning to occur
- Research on the subject has been mostly restricted to other areas. Previous studies have not treated road infrastructure in relation to road traffic accidents in much detail. It is with this background that the current study seeks to assess the condition of road characteristics in a holistic approach to better understand conditions of our roads and its relationship with road traffic accidents and design interventional strategies targeting these risk factors thereof. Roads unsuitable for motor vehicles – such as narrow roads, low quality surfaces, undefined crossing sites, dangerous curves/intersections; poor visibility, lack of sidewalks; lack of proper signs, signals, markings, intersection layout and control. It is against this background that this study was carried out to assess the effects of road infrastructure on road traffic accidents.

Several interventional strategies from various studies and conferences have been implemented to reduce road traffic accidents in Ghana. However, the problem looks unchanged and even increasing at alarming rate. Notably among,

measures put in place to reduce road traffic accidents was the African Road Safety Conference held from 5 - 7 February 2007 in Accra, Ghana. It was co-organized by the UN Economic Commission for Africa and World Health Organization, with support from a number of agencies notably the Swedish International Development Agency. The main objectives were to review progress made by African countries in improving road safety and identify ways of mobilizing resources to rapidly improve road safety. Also, the National Road Safety Commission of Ghana set a mark in the National Road Safety (2011 - 2015 (NRSC - III) focused on abating road traffic fatalities on a year by year basis to attain a total of less than 1,000 fatalities by the year 2015. After 8 years of that strategy, road traffic accident is still increasing at an alarming rate.

As a major emerging public health issue, it is important that, we as a country, take pragmatic steps to stop the carnage on our roads by implementing effective measures that address road traffic accidents.

The results of the study would contribute to increase knowledge about the relationship between road design and road traffic accident. In addition, it would contribute to the knowledge about the usefulness of driving simulators as a tool for transport engineers to test and evaluate the effects of new road layout, work zones, signs and signals, pavement markings, new construction and vegetation designs etc. prior to costly deployment.

Research objectives

Main objective

The main objective of the study was to assess the effects of road infrastructure on road traffic accidents in Ghana, a case study of the Ashanti region of Ghana.

Specific objectives

The first objective was to assess the condition of road infrastructure in the region.

The second objective of the study ascertained the relationship between road infrastructure and road traffic accidents.

The study also investigated the availability of road safety signs in the region.

Addition to the above was to evaluate the relationship between user information on road safety signs and road traffic accidents.

Last but not the least the study provides recommendations to help reduce road crashes in the region.

Justification of the study

Ghana, like other developing countries has a high incidence of road traffic accidents. Despite heightened efforts to reduce road traffic accidents over the last decade, the country has lagged behind in achieving agreed targets. It is unacceptable for almost 2,000 people to die as a result of road traffic accidents every year. Premature deaths and disabilities as a result of road traffic accidents are usually predictable and prevention is possible if effective measures are put in place to manage the situation.

At the intersection of public safety and public health lies the potential to view road traffic accidents prevention through a new lens. Road traffic accidents (RTAs) have emerged as an important public health issue which needs to be tackled by a multi-disciplinary approach. The trend in RTA injuries and death is becoming alarming in countries like Ghana. The number of fatal and disabling road accidents happening is increasing day by day and is a real public health challenge for all the concerned agencies to prevent it. The approach to implement the rules and regulations available to prevent road accidents is often ineffective and half-hearted. Awareness creation and strict implementation of traffic rules are the need of the hour to prevent this public health catastrophe. Previous studies have not treated condition of road infrastructure and availability of road signs in much detail. In Ghana, the link between road infrastructures and road traffic injuries has not been properly examined. Relatively minute research on road condition related injuries are available for developing countries in general, principally those in Africa and Ghana is no exception. It is therefore necessary to bring the impact of road condition on road safety in Ghana into the public recognition through empirical research. This is expected to evoke policy interest and give rise to the formulation of interventions and countermeasures which might help in scaling down road condition-related traffic injuries and deaths. This study intends to come out with road infrastructure related factors in relation to road traffic accidents and create awareness among all stakeholders about the various modalities available to reduce road traffic accidents and to inculcate a sense of responsibility toward spreading the message of road safety.

Conceptual definitions

Road Conditions. the collection of factors describing the ease of driving on a particular stretch of road, or on the roads of a particular locality, including the quality of the pavement surface, potholes, road markings, and weather.

Pavement. the road regarded as a geo construction. The pavement is pedestrian walkway alongside the road.

Pedestrians Crossing. designated point on a road where road marking or other means help pedestrian's cross safety.

Road Traffic Safety. process to reduce the harm (deaths, injuries, and property damage) that result from vehicle crashes on public roads.

Shoulder. a clear level area to the side of the roadway available for stopping if needed.

Traffic. pedestrians, ridden or herded animals, vehicles, bicycles, and other conveyances using any road for purposes of travel.

Literature review

This section reviews the empirical evidence of Road Traffic Accidents worldwide as a result of condition of roads

infrastructure. Firstly, the section establishes the global trend and perspective of road traffic accidents, ascertain road user's knowledge on the effect of road infrastructure on road traffic accidents, examines road infrastructure from a global perspective and in addition underlines the relationship between road infrastructure and road traffic accidents.

Addition to the above, the section reviews the condition of road infrastructure in the Ashanti region of Ghana and also ascertain user's information on road safety signs. Last but not the least, the study provides recommendations to help address road crashes in the region.

The study seeks to find out answers to the following research questions.

1. What is the condition of road infrastructure in the region?
2. What is the relationship between road infrastructure and road traffic accidents?
3. What is the status of road safety signs in the Ashanti region of Ghana?
4. What is the relationship between road user's information on road safety signs and road traffic accidents?

Condition of road infrastructure

Marzida, Abdul Manaf (2010), relationship between roadside features and road traffic accidents.

This research has proven that there is a strong relationship between the critical distance of the roadside features with the increasing number of road traffic accidents. Road width, horizontal and vertical alignment, roadsides and road markings are all identified as factors influencing the driver's perception of the traffic situation as well as the perception of his own driving speed thereby contributing to road safety, especially in rural areas (Zakowska, 1997; Sagberg, 2003).

Shoulders are important features of all roads. They serve a wide range of functions. From human factors standpoint, these functions include: provision for sufficient horizontal distance, as it is an obstacle free zone. The shoulder serves as a primary area clear of obstacles, for recovery of temporary loss of control, or as a provision of space to perform emergency actions (RIPCORD-ISEREST, 2007). Hard shoulders are perceived as an extra driving space. During the last decades, numerous studies have been carried out to identify the road safety effects of shoulder surfacing. For example, in the Netherlands a 20% reduction of accidents on rural single carriageway roads has been estimated (SWOV, 2007).

The risk of injury and fatal accidents may increase with trees along the road as trees are by far the most commonly struck object type in relation to run-of-the-road accidents (Mok et al., 2006). A survey, held on Esrumvej during December 2002, indicated that according to drivers, the main safety problems along the route were narrow traffic lanes, trees which are too close to the road edge and sharp bends (Wrisberg et al., 2005). As the road was designed and constructed several decades ago, it does not fulfil the safety requirements of nowadays.

The relationship between road infrastructure and road traffic accidents

The relationship between road characteristics and number of accidents is reported in several studies. The character of the studies varies in types of roads studied, number of road characteristics studied and choice of method of analysis. In spite of the said variations, the literature still provides an estimate of which characteristics are expected to influence the number of accidents on a certain road section, and therefore which to include in an analysis. On the basis of the literature reviewed, a number of hypotheses are presented in this paragraph. Carriageway and lane widths indicate the room for manoeuvres by the road users. In all likelihood the chance of getting an out-of-control vehicle back on track is higher when

the room for manoeuvre is big. Some studies find no significant relation between the number of accidents and carriageway/lane width. Most of the studies that do find a relation show that the number of accidents decreases as the carriageway/lane width increases (Hadi, Arulldhas et al. 1995, Zegeer, Council 1995, Nielsen, Nielsen 1998, Karlaftis, Golias 2002). Another kind of relation is showed in two studies from the USA and Sweden respectively. In these studies, an increase in the number of accidents was found with an increase in carriageway width up till 5.8 m and lane width up till 3.5 m, at widths above this level the number of accidents decreased with an increase in width (Milton, Mannering 1998, Othman, Thomson et al. 2009).

The shoulder gives the road user room for manoeuvre in case of lost control. Several studies have included width of the shoulder with or without hard shoulder in their analyses. In studies where the width of the shoulder is showed to have a significant influence on the number of accidents it is always the case that the number of accidents decreases as the width increases (Hadi, Arulldhas et al. 1995, Milton, Mannering 1998, Zegeer, Council 1995, Lee, Mannering 2002, Polus, Pollatschek et al. 2005).

Crossing traffic flows create potential conflicts; therefore, the number of potential conflict points along a road increases as the number of access points increases. Access points can either be intersections or road access to fields or private property. Some studies distinguish between intersections and road access, whereas all access points are seen as one variable in others. Equal for all studies they find that the number of accidents increases with the density of access points (Hadi, Arulldhas et al. 1995, Karlaftis, Golias 2002, Polus, Pollatschek et al. 2005, Vejdirektoratet, Trafitec 2011).

Most studies of the effect of bicycle paths are performed in urban areas. A major reason for the lack of studies in rural areas is the lack of data about the number of cyclists and accidents involving cyclists. In the Handbook of Road Safety Measures from the Institute of Transport Economics in Norway, a number of evaluations of bicycle paths are gathered in a meta-analysis. The analysis shows that the number of accidents involving bikes decreases on road sections between intersections after a bicycle path is constructed, but the number of accidents increases at intersections (Elvik, Høye et al. 2009).

The effect of road markings along the road, centerline and lines along the shoulder has not been studied in recent years. Some older studies are gathered in a meta-analysis in the Handbook of Road Safety Measures from the Institute of Transport Economics in Norway. This analysis points to a minor decrease in the number of accidents as road markings are implemented on roads with no previous markings (Elvik, Høye et al. 2009). More recent studies of road markings along the road are concentrated on road markings with acoustic features. Most studies find that the number of accidents decreases as the carriageway width increases. However, two international studies find that the narrowest roads have the lowest number of accidents, after which there is sudden rise in accidents as the carriageway. (Elvik, Høye et al. 2009).

Methodology

This section explains methodology that was used for the study. This part of the study is made up of the study area, study design, target and study population, sample size, sampling techniques, research instruments, data collection techniques, data collection tools, data quality control, data management and analysis and ethical considerations.

Description of the study site

The study was done in Ashanti region of Ghana. This part of the study was design to explore the demographic characteristics of the study population, vegetation, culture, and road network.

Demography

The study was carried out in the Ashanti region of Ghana.

The current population of Ghana is estimated to be 30.10 million, up from the official 2010 census figure of 24.2 million. The capital and largest city of Ghana is Accra, which has an urban population of 2.27 million. The Greater Accra Metropolitan Area (GAMA) has about 4 million inhabitants, which makes it the 11th largest metro area in Africa. (Ghana Statistical Service Report, 2018).

The Ashanti Region is located in the southern part of Ghana and is third largest of 16 administrative regions, occupying a total land surface of 24,389 km² (9,417 sq mi) or 10.2 per cent of the total land

area of Ghana. In terms of population, however, it is the most populated region with a population of 4,780,380 according to the 2011 census, accounting for 19.4% of Ghana's total population. The Ashanti Region is known for its major gold bar and cocoa production. The largest city and regional capital are Kumasi. Ashanti Region has common boundary with Brong Ahafo Region in the north, Central Region in the south, Eastern Region in the east and Western Region in the west. (Ashanti Region Archived August 28, 2010, at the Wayback Machine).

Vegetation

The vegetation is broadly classified into two: Semi deciduous forest and Guinea Savanna woodland. The average annual rainfall is about 166.7cm (66 inches) and the temperature is generally high, average over 27 C in the forest zone and 29 C on the northern fringes of the forest zone. The humidity is relatively high, averaging about 85% in the forest area and 65% for the Savannah belt. (Ashanti Region. geohive.com).

Culture

Ashanti Region has 33 traditional councils, and each is headed by a Paramount Chief. All these Paramount Chiefs in turn owe allegiance to Otumfuo, the Asantehene. The region is often referred to as the seat of the country's culture due to the fact that several items that portray the Ghanaian culture like pottery, kente weaving, wood carving, traditional sandals, beads, smithing and a lot more can be found in the Region. ("Ashanti Region". *GhanaDistricts*. Retrieved 29 December 2017). The main economic activity in the region is agriculture. Major crops grown include cocoa, oil palm, plantain, maize, yam, cassava, vegetables and citrus.

Road network

Road network to major towns and villages is very bad. Kumasi, the regional capital, is centrally placed and easily accessible by road from almost all parts of the country. Parts of Sekyere East, Sekyere West, Asante Akim North and Ejura Sekyedumase districts are however inaccessible most of the time, especially during the rainy season. ("Ashanti Region". *GhanaDistricts*. Retrieved 29 December 2017).

Study type

A non-experimental cross-sectional study design was used to collect data to assess the condition of road infrastructure in Ashanti region. A cross-sectional study involves looking at people who differ on one key characteristic at one specific point in time. The data was collected at the same time from people who were similar in other characteristics but different in a key factor of interest such as age, educational background, or a geographic location. Cross sectional studies are usually relatively inexpensive and allow researchers to collect a great deal of information quite quickly. Data is often obtained using self-report surveys and researchers are then able to amass large amounts of information from a large pool of participants. It helped the study to determine if exposure to specific risk factors might correlate with particular outcomes. It provides a quick look at correlations that may exist at a particular point. Therefore, this design was used to determine if exposure to specific risk factors (road conditions) might correlate with road traffic accident.

Study population

The study participants were made up of motor vehicle users, pedestrians, National Road Safety Commission, Ministry of Road and Highways and Ministry of Transport.

Sampling size

A total of 217 respondents were selected for the study. The selection of the sample size was based on the prevalence rate of 17% of road traffic accident deaths in the region, reported by the Motor Traffic and Transport Department of the Ghana Police Service, 2018.

$n = z^2 (pq)/d^2$ (Wayne 2006) Where

n = sample size

z = Reliability Coefficient with 95% confidence interval

p= Population variance available from previous data, where q = 1-p

d = the desired or the required size of standard error allowed. If the value of p is 0.17 and the desired standard error chosen to be 0.05 with reliability coefficient of 95 % certainty ($z = 1.96$).

$$\text{Then, } n = \frac{[(1.96)^2 (0.17 \cdot 0.83)]}{(0.05)^2}$$
$$n = 216.8 \approx 217$$

Sampling technique

The political administration of the region is through the local government system. Under this system, the region is divided into 30 districts made up of 1 Metropolitan, 7 Municipalities and 22 Ordinary districts. The study was conducted in the metropolitan and the selected 4 municipalities in the region. The only metropolitan, that is the regional capital (Kumasi) was conveniently selected and probability sampling method, specifically simple random sampling method was used to select four (4) municipalities out of the 7. This was to ensure that every municipality has an equal chance of being incorporated into the sample. Kumasi, Mampong, Obuasi, Agona, and Konongo were selected for the study.

Study methods

The study used both quantitative and qualitative methods. Johnson & Turner, (2003) opined that the underlying principle of mixed methods research is that, multiple types of data could be collected with different strategies and methods in ways that reflect complementary strengths and non-overlapping weaknesses, allowing a mixed methods study to provide insights not possible when only qualitative or quantitative data are collected. Greene, (2007) has indicated that mixed methods research gives the researcher the opportunity to compensate for inherent method weaknesses, capitalize on inherent method strengths, and offset inevitable method biases (pg. xiii). The mixed methods approach was used as sequential transformative design. Here, qualitative data was collected first and based on the analysis, the results was used to develop questionnaire for the quantitative data. Primary method of data collection was used to collect data from the metropolitan and the four (4) municipalities that were selected for the study. In each of the 5 selected study areas, 20 motor vehicle users participated in the study. The participants were selected through simple random sampling method. This was done by written 20 YES and 20 No's on piece of papers, folded and thoroughly mixed in a bowl.

Any driver who was willing to take part of the study after the purpose of the study was explained to him was called to pick one of the folded papers. Any driver who picked yes was selected for the study. In all 100 motor vehicle users participated in the study. Interview was organized at each selected study area to ascertain pedestrian knowledge on the condition of road infrastructure as well as road signs in relation to road crashes. In each of the selected study area, 20 respondents were selected. Focus group discussion was also organized in the regional capital, Kumasi to ascertain National Road Safety Commission officer's knowledge on the relationship between road infrastructure and road traffic accidents. Data was gathered from a team made up of 8 members. Study participants were conveniently selected. Also focus group discussion was organized for the staff of Ministry for Roads and Highways. Nine (9) people were conveniently selected.

Data collection techniques or tools

Questionnaire made up of both open and close ended were used to collect data from both motor vehicle users and pedestrians. For the pedestrians, systematic sampling technique was used to select the houses. This sampling method was used to reduce the burden of simple random sampling method. It was also used because the researcher wanted to cover a large area in order to avoid bias. At the selected house, the head of the household was selected for the study. The study considered household heads who were 18 years or above. In a house where there were more than one household, the selection was done by written 1 YES and NOs on piece of papers, folded and thoroughly mixed in a bowl. Any household head who was willing to take part of the study after the purpose of the study has been explained to him /her was called to pick one of the folded papers. Any person who picked yes was selected for the study.

Quality control

Data collectors for both, questionnaire administration and focus group discussions were recruited and trained. The details of the study procedures regarding the selection criteria, the interpretation of

items in the instruments were thoroughly discussed. This was done to ensure that there is uniformity in understanding and translating of the questions in the tools so as to strengthen its reliability and validity. The data collection was conducted and completed tools examined, corrected and was kept with the researcher under lock and key.

Data processing and analysis

In the quantitative analysis, data was entered into the computer and checked for completeness through cleaning. Quantitative data was entered into the computer using the Statistical Package for Social Science (SPSS) version 19, and also Chi-Square statistical data analysis was used to analyses data. Data was analyzed to ascertain the condition of road infrastructure and its relationship with road traffic accidents in the Ashanti region of Ghana. Quantitative data was transcribed into an excel spreadsheet for analysis. Quantitative data were analyzed within the framework of the objectives of the study.

Ethical consideration

Ethical clearance for the study was obtained from the Ethical Review Committee of the school. Permission to undertake the study in the region was sought and granted by the Regional Metropolitan Police Headquarters of the Motor Traffic and Transport Department. The subjects were provided with informed consent forms before they were recruited into the study.

Pre-test

The instruments were pre-tested on 15 drivers, 10 passengers and 10 transport officers who were not part of the main study in one of the municipalities and the necessary corrections were made before the instruments were finally administered to the actual study participants.

Results and discussion

This part of the study analyses the findings of the 217 respondents interviewed, of which 100 respondents were motor vehicle users, 100 were pedestrians, National Road Safety Commission (8) respondents, and Ministry of Road and Highways (9) respondents. The presentation of the results is based on the objectives of the study.

Table 1. Demographic characteristics of respondents

Parameter	Total Population (n=217)	Percentage (%)
Marital Status		
Single	67	(30.88)
Married	150	(69.12)
Religion		
Christianity	143	(65.90)
Islam	56	(25.81)
Traditional	18	(8.29)
Educational Status		
No Education	37	(17.05)
Basic	61	(28.11)
Secondary	75	(34.56)
Tertiary	44	(20.28)
Age		
19-28	48	(22.12)
29-38	64	(29.49)
39-48	55	(25.35)
49-58	50	(23.04)
Average age	38.43	

Data is presented as figures with percentages in parenthesis, and averages. N- Number, %- percentage. Table 1 above indicates that majority (58.99%) of the study participants were males while 41.01%

were females. Most (69.12%) were married couples. From the table above, the study found that, 65.90% of the study population were Christians and only 8.29% were traditionalists. Majority of the respondents (34.56%) had formal education up to Senior High School and 17.05% had no formal education. Most (29.49%) of the study participants were within the age range of 29–38 and the average age of the respondents was 38.43.

Table 2. Distribution of respondents by condition of roads

Parameter	Total Population <i>n</i> =217	(%)
Roads well maintained with frequent relaying of road surfaces and markings road safety signs		
Excellent	0	0.00
Very good	0	0.00
Good	0	0
Need to be improved	42	19.35
Poor	175	80.65
Proper footpaths for pedestrians crossing at intersection		
Excellent	0	0.00
Very good	0	0.00
Good	0	0.00
Poor	217	100
Separate lanes for slow-moving and fast-moving vehicles		
Yes	0	0.00
No	217	0.00
Condition of roads, junctions and road visibility		
Excellent	0	0.00
Very good	0	0.00
Good	10	6.61
Need to be improved	73	33.64
Poor	134	61.75

Table 2 indicates study participants perception on the conditions of road well maintained with frequent relaying of road surface and markings road safety signs, majority (80.65%) said that it is very poor. The table under discussion shows that when the study participants were asked of the condition of the footpaths for pedestrians crossing at intersection, all (100%) of the respondents responded poor to the question. Addition to the above, all the respondents said that there were no separate lanes for slow-moving and fast-moving vehicles. Of the question on condition of road, junction and road visibility, 61.75% of the respondents said poor, 33.64% said need to be improved and only 6.61% said it is good.

Table 3. How road traffic accidents are caused as a result of bad roads

Parameter	Total Population <i>n</i> =217	(%)
Work zones issues	12	5.53
Confusing signage	29	13.36
Pavement marking issues	33	15.21
Inadequate signage	46	21.20
construction zones with uneven pavement	16	7.37
Sudden driver manoeuver	14	6.45
Single lane driving	67	30.88

Table 3 shows that, majority (30.88%) of the respondents indicated that road traffic accidents are caused as a result of single lane driving, 21.20% said inadequate signage and only 5.53% answered work zone issues.

Table 4. Distribution of respondents by exposed and unexposed to bad roads and out come

Parameter	Total Population (n=217)	
	Exposed	Non-exposed
1. Exposed to bad road surface and poor markings of road safety signs	184 (84.79)	33 (15.21)
If exposed or non-exposed, did you experience RTA?		
Yes	69 (37.50)	6 (18.18)
No	115 (62.50)	27 (81.82)
2. Exposed to lack of footpaths for pedestrians crossing at intersection	191 (88.02)	26 (11.98)
If yes or no, were you nearly or involved in road crashes?		
Yes	81 (42.41)	5 (19.23)
No	110 (57.59)	21(80.77)
3. Exposed to lack of separate lanes for slow-moving and fast-moving vehicle	202	15
If yes or no, were you nearly or involved in road crashes?		
Yes	128 (63.37)	5 (33.33)
No	74 (36.63)	10 (66.67)
4. Exposed to bad roads, junction, and poor road visibility	179	38
If yes or no, were you nearly or involved in road crashes?		
Yes	67 (37.43)	6 (15.79)
No	112 (62.57)	32 (84.21)
5. Exposed to lack of road signs and signals, lack of bicycle lanes, and lack or poor pavement markings	198	19
If yes or no, were you nearly or involved in road crashes?		
Yes	153 (77.27)	5 (26.32)
No	45 (22.73)	14 (73.68)

Data is presented as figure with percentages in parenthesis, and averages. N- Number, %- percentage. Table 4 indicates that out of 184 respondents who have ever been exposed to bad road surface and poor markings of road safety signs, 69(37.50%) have ever been involved in road crashes 115(62.50%) were exposed but never involved in road crashes, and participants who were not exposed, 6(18.18%) have experienced road traffic accidents before and 27(81.82%) have not. It was observed during data collection that, safety improvement such as traffic signs, crash barriers, raised pavement markers, zebra crossing and other forms of road surface marking are not installed and there was no clear level area to the side of the roadway available for stopping if needed. It was also observed that, roads in the region are too bumpy to drive on. The study found that road infrastructure in the region is generally poor. They are little better during the dry season and worse during the wet season. It was scanned during the study that, 35% of the roads are tarred but have outlived their life span, therefore they are in bad condition causing danger to road users. 50% of the roads are gravel and earth and becomes in accessible during wet season.

The study found that there is an association between bad road surface, poor markings of road safety signs and road traffic accidents. Using Pearson's Chi Square with Z for 95% CI = 1.96, with $p=0.03$, the result is significant at $p=0.05$. Also, T-test = 0.025 for 95% CI = 2.007. Therefore, the current study concluded that, bad road surface, poor markings of road safety signs and road traffic accidents are not independent. Relative risk calculation indicates that, exposure increases the risk of 20% of involving in road traffic accident.

The finding of this study is in lined with a study conducted by Elvik, Hove et al. 2009. From his findings, the effect of road markings along the road, centerline and lines along the shoulder has not been studied in recent years. According to him, some older studies are gathered in a meta-analysis in the Handbook of Road Safety Measures from the Institute of Transport Economics in Norway. This analysis points to a decrease in the number of accidents as road markings are implemented on roads with no previous markings (Elvik, Høye et al. 2009). More recent studies of road markings along the road are concentrated on road markings with acoustic features.

In the same table, 191(88.02%) of the study participants who have ever been exposed to lack of footpaths for pedestrians crossing at intersection 81(42.41%) have ever been involved in road traffic accident and 110 (57.59%) have not even though they were exposed. The study found that those who were not exposed, 5 of them have ever been involved in road crashes while 21 respondents have not. The Chi Square calculated p value is 0.0234, calculated value for T test is 0.025 and Fisher exact test is 0.012. The study result is statistically significant at $\alpha = 0.05$. The study established that, there is a strong correlation between exposed to road that has no footpaths for pedestrians crossing at intersection. The study observed that pedestrians who are exposed to a road without footpath have 22% risk of involving in road traffic crashes.

The outcome of this study is not in agreement with Vejdirektoratet, Trafitec, 2011. According to their findings, crossing traffic flows create potential conflicts; therefore, the number of potential conflict points along a road increases as the number of access points increases. The previous studies indicated that, access points can either be intersections or road access to fields or private property. Some studies distinguish between intersections and road access, whereas all access points are seen as one variable in others. Equal for all studies they find that the number of accidents increases with the density of access. The findings of this study do not support the idea that road traffic accident increases with the density of access, either intersections or road access to field or private property. The current study found that road traffic accidents increases when there is limited access to intersection for motor vehicle users and pedestrians, road traffic accident increases. Table 4 above shows that, 202 study participants have ever been exposed to lack of separate lane for slow-moving and fast-moving vehicles. Out of this figure, 128(63.37%) had ever been involved in road traffic accident while 74(36.63%) of the respondents had not. Study participants who were not exposed, 5(33.33%) had ever been involved in road crashes and 10(66.67%) had not.

The current study observed and indicated that road users who are exposed to roads without separate lanes for slow-moving and fast-moving vehicles have risk of engaging in road traffic accident. The study therefore concluded that roads without separate lanes for slow-moving vehicles and fast-moving vehicles are related to road crashes. At $\alpha 0.05$, that is z for 95% CI =1.96, the result of the study is statistically significant at $p = 0.05$. The calculated p value using Chi Square statistical analysis is 0.02 and Fisher exact test is 0.017. Road users who are exposed roads without separate lanes for slow moving and fast-moving vehicles have 19% risk of experiencing road traffic accident. It is indicated in table 4 that, 67(37.43%) of the study participants had ever been involved in road crashes as a result of being exposed to bad roads, poor junctions, and poor road visibility. 112 of those exposed were not involved in road crashes. However, 32 of the study participants were not exposed to the risk factor but 6 of them became victims to road traffic accidents. Inferential statistics for this study proved that, exposure to bad roads, poorly designed junction, and poor road visibility are associated with road traffic accidents. Using Chi Square statistical analysis, the calculated p value is 0.01. Therefore, the result is statistically significant at $\alpha = 0.05$. This finding is also supported by Fisher exact test = 0.0048.

The finding supports the previous related work. Studies of the relationships between geometric design and road accidents in Kenya and Jamaica and research in Chile and India showed that apart from traffic flow, junctions per kilometer was the most important factor related to accidents, followed by horizontal and vertical curvature. The study proposed using accident reduction and prevention measures as a way of meeting the challenges of traffic safety in developing countries It is also captured in table 4 that, 198 study participants had ever been exposed to roads without road signs and signals, roads without bicycle lanes, and roads without pavement markings. Out of this number, 153(77.27%) had ever involved in road crashes. 45(22.73%) of the respondents even though were exposed but never

involved in road crashes. Participants who were not exposed, 5(26.32%) had ever been involved in road crashes but 14(73.68%) had not.

Inferential statistics for this observation proved that, exposure to roads without signs and signals, roads without bicycle lanes, and roads with no pavement markings are associated with road traffic accidents. The current study found that there is a strong correlation between road users exposing to roads without signs and signals, without bicycle lanes and non-availability of pavement markings and road crashes. Using Chi Square statistical analysis, the calculated p value is 0.00. Therefore, the result is highly statistically significant at alpha 0.05. The finding of the study mirrors a previous study conducted by Elvik, and Vaa (2004). Elvik and Vaa (2004) undertook meta-analyses of various interventions related to signals. They concluded that, following signalization, collisions decreased by 15% (95% confidence interval from -25% to -5%) at 3-arm junctions and 30% (95% confidence interval from -35% to -25%) at 4-arm junctions.

Conclusion

The study sought to investigate the effects of road infrastructure on road traffic accidents. The study found that the road infrastructure in the region is generally poor. The findings observed that bad roads and road traffic accidents in the region are significantly related. The study concludes that, to reduce road traffic accidents in Ghana, road infrastructure is one of the key independent variables that major stakeholders in this field should tackle. The study found strong association between poor road infrastructure and road traffic accidents. It is indicated in the study that roads not being well maintained with frequent relaying of road surfaces and markings of road safety signs poses danger to road users. Also, the study observed that lack of or improper footpaths for pedestrians and pedestrian crossings at intersections, not providing separate lanes for slow-moving and fast-moving vehicles, roads junctions not being wide and poor road lightening leading to poor road visibility have all been linked to road traffic accidents. The study found that, poorly maintained roadways cause accidents in a variety of ways, mostly due to the fact that they create an enormous hazard to drivers. In many instances, a driver may attempt to avoid a certain situation, like a pothole or pooling water which could cause a serious accident. Severe accidents can occur when blacktop or asphalt are missing in large chunks from the road and a drop-off region can present a serious danger to drivers. The study also established that, confusing signage and inadequate signage should be considered in order to reduce road crashes.

Recommendation of the study

The findings showed that bad roads have effects on road safety. It is therefore recommended that government should formulate a good road infrastructure policy that will enhance the sustainability of road infrastructure and should also encourage public participation in road infrastructure provision and maintenance to reduce road traffic accident.

Also, the current study suggests that, various government agencies and private entities, including local news services, track and report on road conditions to the public, so that road users going through a particular area can be aware of hazards that may exist in that area. Roads should be well maintained with frequent relaying road surfaces and markings of road safety signs. Provide proper footpaths for pedestrians and pedestrian crossings at intersections. Provide separate lanes for slow-moving and fast-moving vehicles. Roads and junctions should be wide and well lighted so that visibility is good. The lay-out of the road should help to improve traffic safety.

Banking / camber

When roads and highways curve, the outside edge of the curve is often raised such that the surface of the road is at an angle. This banking of the roadway takes the speed of traffic into consideration, makes it easier for vehicles to navigate the curve, and makes it less likely that a vehicle will go off the roadway at a curve. When the banking of a roadway is either insufficient or excessive, danger to motorists can increase.

Barriers and guard rails

Well placed barriers, guard rails, speed bumps, medians, curbs, and other similar devices can help separate lanes of traffic, and help prevent vehicles from crossing the median or otherwise leaving the

roadway. Where such devices are inadequate in design or implementation, they can leave drivers vulnerable, or can even contribute to accidents.

Entry and exit ramps

Although in some areas traffic congestion makes it impossible to avoid backups at highway entry and exit ramps, good design can lessen congestion, provide adequate room for vehicles to merge, and avoid pinch points where vehicle density makes it difficult to change lanes.

Road markings

The markings on a roadway should be visible and understandable to motorists. Sometimes the use of reflective markings and reflectors can help drivers stay in their lanes at night or in poor weather conditions. The proper use of broken and solid lines to designate areas where passing is safe or forbidden, and the proper coloration of lane markings and the fog line, can help make travel safer.

Road surface

Different road surfaces offer different levels of friction. Where a higher level of friction is desired, the use of concrete as a road surface instead of asphalt can make a significant difference. Rumble strips and grooves can be used to help warn drivers of upcoming hazards, or that they are starting to drift out of their traffic lane or onto a shoulder.

Shoulder design

Providing an adequate shoulder can improve the safety of a road by providing a buffer space between vehicle traffic and a barrier or ditch, and by providing motorists with a location to safely pull off the road in the event of mechanical failure. Road design should avoid any sudden drop-off from the paved roadway onto the shoulder.

Signage

Well-placed, properly illuminated signs make it easier for drivers to anticipate upcoming intersections and hazards, and make it less likely that they will become lost or confused.

Traffic control devices

Appropriate placement of traffic signals, stop and yield signs, lights to designate intersections, school crossings, and pedestrian crossings, and other devices to control the flow of traffic, can improve safety for both drivers and pedestrians.

Traffic flow patterns

When roads are designed, traffic speed and density should be considered. At highway speeds, roads are safest when the traffic lanes for each direction are separated. In dense urban areas, one-way roads may improve traffic flow - but the excessive use of one-way roads can also confuse drivers and impede traffic. Rural highways, with one traffic lane in each direction, tend to be more dangerous than roads with multiple lanes due to unsafe passing and an associated increased risk of head-on collision.

Visibility

Road design should take the terrain and local weather into consideration, including whether an area is susceptible to fog or flooding, and should attempt to avoid points of diminished visibility due to hills, curves, or at points of hazard. Buildings and structures should be appropriately set back from the road, and trees and foliage should be trimmed as necessary.

Contribution to knowledge

The findings of the study would contribute to promulgate and increase knowledge about the relationship between road design and road traffic accidents. In addition, it would contribute to the knowledge about the usefulness of driving simulators as a tool for transport engineers to test and evaluate the effects of new road layout, work zones, signs and signals, pavement markings, new construction and vegetation designs etc. prior to costly deployment.

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