Dissertation

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UNIVERSITY OF CAPE COAST

Determinants of Road Traffic Crashes on the Accra-Cape Coast Highway in Ghana

MAY 2012

UNIVERSITY OF CAPE COAST

DETERMINANTS OF ROAD TRAFFIC CRASHES ON THE ACCRA- CAPE COAST HIGHWAY IN GHANA

BY

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THESIS SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY AND REGIONAL PLANNING OF THE FACULTY OF SOCIAL SCIENCES, UNIVERSITY OF CAPE COAST, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR AWARD OF MASTER OF PHILOSOPHY DEGREE IN GEOGRAPHY

MAY 2012

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this University or elsewhere.

Candidate's Name: Enoch Frederick Sam

Signature: .... Date: ....

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Name: Prof. Albert M. Abane

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Co- Supervisor's Name: Dr. Kwaku Boakye

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ABSTRACT

Certain in-vehicle engineering safety features have been found to be associated with measurable human behaviour feedback and thus crash involvement. The intended effects of road-safety measures are sometimes offset by behavioural adaptation among road users. For instance, the hypothesis of risk compensation implies that as interventions reduce the risk associated with particular actions individuals will choose riskier actions (e.g., driving faster).

The study set out to test the risk compensation hypothesis on the Accra - Cape Coast highway. Guided by the Jorgensen and Abane (1999) Model for Road Traffic Accidents and Peltzman's Risk Compensation Hypothesis (1975), the study employed a questionnaire and observation as the main data collection instruments. A total of 104 private car drivers responded to the questionnaire. Binary logistic regression and chi square statistic were used in evaluating the hypotheses- driver speed choice and driver risk taking behaviour and effect of road improvement on road traffic casualties.

The study found that driver speed choice and driver risk taking behaviour were a function of many factors including gender, age, driving experience, the particular car model one drives and the safety devices installed in it as well as one's confidence that the safety devices would work in emergency situations . The study concluded that drivers show behavioural adaptation to safety devices in their vehicles and the highway condition and males are more likely than females to take risk.

ACKNOWLEDGEMENTS

This work naturally owes its success to a number of people who were very instrumental in bringing it to completion.

Firstly, I would particularly like to thank my supervisors Professor Albert M. Abane and Dr. Kwaku Boakye, for painstakingly reading and editing this work. I am much grateful for their suggestions towards this work, without which this work would not have come this far.

Again, my warmest gratitude goes to Mr. Afukaar of the BRRI of CSIR, for providing me data on the road traffic crashes in the country especially on the Accra- Cape Coast highway and CODESRIA and IFRA- Nigeria for their immense contribution towards the research in general.

My heartfelt appreciation also goes to Mr. Aikins of the Department of Geography and Regional Planning for his insightful comments and recommendations during the course of the work.

My thanks would be grossly incomplete, should I leave out my family members and friends who assisted me in diverse ways, especially Mr. Foster Frempong for his guidance during the data analysis and formatting.

However, I am singularly responsible for any defects and shortcomings in this work.

DEDICATION

To the Sam family in Cape Coast

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LIST OF ACRONYMS

ABS	Anti- Lock Braking System
ACC	Adaptive Cruise Control
ASP	Active Stability Program
BRRI	Building and Road Research Institute
CSIR	Centre for Scientific and Industrial Research
DBQ	Driver Behaviour Questionnaire
DSC	Dynamic Stability Control
DVLA	Driver and Vehicle Licensing Authority
EACS	European Accident Causation Survey
ESC	Electronic Stability Control
ESP	Electronic Stability Program
GDP	Gross Domestic Product
GM	General Motors
HMCs	Highly Motorized Countries
LMCs	Less Motorized Countries
LOC	Loss of Control
MTTU	Motor Traffic and Transport Unit
NHTSA	National Highway and Traffic Safety Administration
NRSC	National Road Safety Commission
RHT	Risk Homeostasis Theory
SIR	Supplemental Inflatable Restraint
SRS	Supplemental Restraint System

SUVs	Sport Utility Vehicles
VSC	Vehicle Skid Control
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

Background of the study

It is a common perception among the public that road crashes are a problem, resulting in death, injury or property damage. Unfortunately, some people do not fully realize the size of the problem. It is clear that while many people, especially in developing countries, have the general idea that driver error is the main cause of the problem, they have no idea that several causes and factors contribute to the problem as well. Their understanding, in most cases, is limited because they have no clear measurement(s) that can show them the size of the problem in a simple and adequate manner (Al-Haji, 2007).

The number of motor vehicles is continuously increasing globally, and road traffic crashes are causing more and more deaths and injuries. The World Health Organization (WHO) statistics (Al-Haji, 2007) indicate that almost 1.26 million people are killed in road crashes each year worldwide, representing 25 per cent of all deaths caused by injuries and an additional 50 million people are estimated to be injured. Nearly half of them are seriously injured or disabled. Due to the unreliability and under-reporting of data in most countries, these figures are still under-estimated. Road crashes are the eighth leading cause of death in the world today, and the World Health Organization (WHO) estimates that it will become the world's third leading cause of death by the year 2020 if no effective actions and efficient measures are taken.

All countries suffer from the road crash problem. However the size of the problem is different from one country to another, because countries vary widely in their development levels, road safety systems and experiences. According to Jacobs, Aeron-Thomas and Astrop (2000), the majority of road deaths and injuries occur mostly in developing and transitional countries. Highly Motorized Countries (HMCs) have sixty percent of the total motor vehicle fleet but their contribution to the total global road crash deaths is only fourteen percent. Several studies have shown that the total number of road deaths in HMCs has been declining or stabilizing during recent decades, whereas the situation in Less Motorized Countries (LMCs) remains severe with the total number of deaths continuing to increase (Al-Haji, 2007). The majority of road deaths take place in developing countries, and the economic cost to the developing world amounts to 100 billion US dollars annually- more than the entire amount of money spent in development aid. The significance of traffic as a health problem is therefore rising, especially in developing countries. Worldwide, road traffic injuries are the leading cause of death for people in the 15–44 age bracket.

Motor vehicle deaths have long been among the ten leading causes of death, and they usually comprise between a third and a half of all accidental deaths. However, the specific role of vehicle design was not a major public policy issue until the mid-1960s when legislation in the USA imposing federal regulation of vehicle design was enacted. While it is overly simplistic to attribute this congressional action to a single source, the widespread attention gained by Ralph Nader's (1965) allegations of design defects in the Corvair in his *Unsafe at Any Speed* appears to have been an important catalyst. Hearings on automobile design began before Nader came to prominence, but the relevant legislation was passed within a year of the publication of his book.

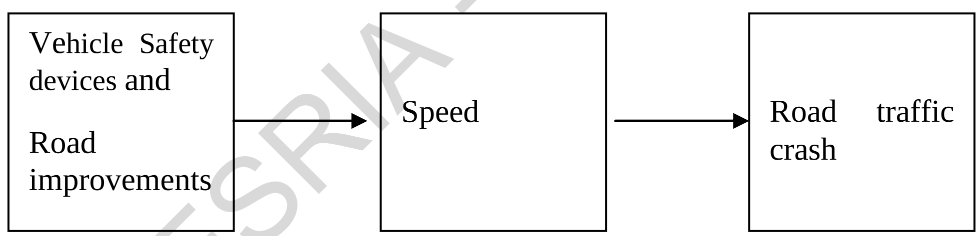
The National Traffic and Motor Vehicle Safety Act of 1966 created what have become the National Highway and Traffic Safety Administration (NHTSA). This agency was empowered to promulgate design standards to which new vehicles sold in the United States had to conform. The first set of these became effective in 1968, and, while they have been subsequently embellished, the 1968 standards remain the most important in terms of their apparent potential for reducing the crash toll. Among the major design changes required by these standards were the following: 1) seat belts for all occupants, 2) energy-absorbing steering column, 3) penetration-resistant windshield, 4) dual braking system, and 5) padded instrument panel. Auto producers responded to congressional pressure for legislation by installing many of the devices that became mandatory in 1968. The most significant of these anticipatory moves occurred in early 1964, when front lap seat belts became standard equipment, and in early 1967, when most manufacturers added energy-absorbing steering columns and penetration-resistant windshields, among other items (Peltzman, 1975)

Since the mid-1960s, governments at all levels have been actively involved in regulating the safety of passenger automobiles. These policies were prompted by a marked increase in automobile fatalities in the early 1960s, and included a series of direct regulations involving seat belts and design features to lower occupants' vulnerability in the event of crash (Chirinko & Harper Jnr., 1993).

Risk compensation is usually defined as behavioural adaptation to a perceived lower risk situation, especially when the lower risk is brought about by an accident countermeasure. This kind of adaptation has been discussed in the road safety research literature for a long time (Assum, Bjornskau, Fosser, & Sagberg, 1999), and theories of behavioural adaptation have been developed (Wilde, 1988).

Peltzman's (1975) risk compensation hypothesis argues that improvements in safety devices in vehicles (e.g. airbags, dual braking systems, etc.) as well as road improvements originally designed to ensure safety invariably serve as incentives to drivers to speed (risk taking) and expose themselves to the risk of crashes. Thus road traffic crash (A) is a function of availability of vehicle safety devices (VSD), road improvements (RI) and speed (S).

i.e. $\mathbf{A = C + b\,(VSD) + b\,(RI) + b\,(S) + e}$



Where A= crash risk, C= constant, b= slope, VSD= availability of vehicle safety devices, RI= road improvement, S= speed and e= error. Crash risk is thus a function of driver risk taking behaviour which could be defined to include but not limited to driver speed choice and driving violations (in terms of drunk driving, tailgating, aggressiveness and impatience on the part of drivers on the road).

The hypothesis of risk compensation is that people experiencing a real or perceived change in the riskiness of an activity will deliberately or subconsciously alter their behaviour to obtain a new combination of risk and reward. If there is risk compensation, then the compensation can more than offset the improvement (Narvaez & Hyman, 2010).

The hypothesis of risk compensation thus implies that as interventions reduce the risk associated with particular actions (e.g. individuals begin to wear safety belts as required by mandatory-use laws, reducing their risk of injury in a crash), individuals will choose riskier actions (e.g., driving faster). This result is the cause of much misunderstanding about the hypothesis, and consequently it is not surprising that testing the hypothesis of risk compensation has proved difficult and controversial (Dulisse, 2007).

Several studies of the effects of road safety measures have produced unexpected results. Measures as different as driver training, wider roads, pedestrian crossings and ABS brakes seem to produce no crash reduction (Assum et al., 1999). It is unclear whether risk compensation or even risk homeostasis (Wilde, 1982) is the reason why these measures do not reduce road crashes.

Because researchers cannot easily observe the specific actions chosen by individuals as a result of an intervention, it is difficult to test the hypothesis directly. As a result, the hypothesis is usually tested indirectly by examining implications of the riskier actions predicted by the hypothesis. For example, it is difficult to observe how drivers change their behaviours as a consequence of a law mandating seat belt use; if these predicted changes in behaviour (e.g., speeding, riskier driving, etc.) are important, we would expect that they would result in more crashes, which can be observed for a large number of individuals (Dulisse, 2007).

The concept of risk compensation is important because it means that the risk reduction that could theoretically be obtained by a system change will not be fully achieved in the absence of strict controls because the users of the system will alter their behaviour in a way that seems favourable to them but that is adverse to overall safety (Narvaez & Hyman, 2010).

Speed is at the core of the road crash problem because higher speed reduces the time available to avoid collision and makes the impact in a collision more severe. Research shows that there is a clear relationship between changes in mean speed and concurrent changes in number of crashes. Finch, Kompfner, Lockwood and Maycock (1994) have brought together evidence about the effects of increases or decreases in average speed on crash frequency on various kinds of road in Denmark, Finland, Germany, Sweden, Switzerland, the UK and the USA. From this evidence, it can be concluded that a 1 km/h increase in mean traffic speed typically results in a 3 per cent increase in crash frequency, whereas a 1 km/h decrease in mean speed results in a 3 per cent crash reduction.

Variation in speeds between vehicles within the traffic stream is also associated with crash occurrence. Those who drive much faster or much slower than the average for the traffic stream are found to be more likely to be involved in crashes (West & Dunn, 1971; Munden, 1967).

The speed at which an individual driver chooses to drive a particular vehicle is the outcome of a complex process involving personal characteristics and circumstances as well as the type of road, its layout and surroundings, the amount and composition of the traffic, and the prevailing environmental conditions.

Vehicle characteristics also affect speed choice, especially on high-speed roads. Increase in vehicle performance has probably contributed strongly to the long-term upward trend in average speeds on high-speed roads (European

Transport Safety Council, 1995). On the other hand, the introduction of a single technology such as seat belts can decrease the number of fatalities. However, the introduction of such a technology may lead to drivers taking more chances on the road due to changes in their perceived safety or vulnerability (Unrau, 2004).

Even with a century's worth of improvements in the human, vehicle, and road environments, collisions still occur, and the vast majority of these crashes are attributable in whole or in part to driver errors and human behaviour (Wouters & Bos, 2000). Since driver behaviour directly affects the three essential tasks of driving – navigation, guidance, and control (Ogden, 1997) it is generally considered the most complex factor in crash prevention. Although the road environment and the vehicle environment are important in the safety equation, ultimately the driver must respond and react to changes in the road environment, otherwise known as behavioural adaptation (Unrau, 2004).

Statement of Problem

The movement towards designing and building safer automobiles began with Ralph Nader's 1965 book, *Unsafe at Any Speed*, which exposed various safety shortcomings with cars produced by the American automotive industry (Zubritsky, 2005). As a result of this initial push towards safer automobiles, many lives have been saved as vehicles of all types have been designed with standard safety equipment such as energy-absorbing steering columns, seat belts, crumple-zones, rounded corners, anti-lock brakes, and more recently air bags. However, safety engineering walks a fine line with promoting reckless driving. Lave and Weber (1970) examined the costs and benefits of automotive safety features, including padded instrument panels, seat belts, energy absorbing steering columns, and dual braking systems. They did not believe that the government should mandate these safety features in cars due to possible market failure associated with government intervention.

Additionally, they argued that having seat belts standard in all cars does not guarantee that the driver or occupants will use them, or use them properly, rendering them ineffective. Another social cost associated with mandated safety equipment, according to Lave and Weber, is that drivers will drive faster if their vehicles have more safety devices. A driver will take greater risk to compensate for the additional safety in order to arrive at their destination sooner.

The intended effects of road-safety measures are sometimes offset by behavioural adaptation among road users. This phenomenon has been demonstrated for several measures both on the individual behavioural level, and on the aggregated crash-risk level (Evans, 1991). Traynor (1993) looked directly at the demand relationship between a driver's environment and his/her behaviour, and found evidence to support Peltzman's hypothesis. He concluded that if a driver is less likely to sustain an injury in a crash, he/she will necessarily respond by driving less cautiously. Keeler (1994) confirmed these results in a study that looked more closely at the cost of crashes, for which he included data on hospital costs as well as demographic and traffic characteristics. Keeler's results provide some support for the offsetting behaviour hypothesis since the data failed to produce evidence that the implementation of safety regulations significantly reduced fatalities.

Apart from the research on studded tyres, drivers with ABS (anti-lock braking system) brakes have been found to drive significantly closer to the car in front (Sagberg, Fosser, & Saetermo, 1997). It is likely that alterations in behaviour such as these are responsible for the finding that ABS brakes do not lead to an overall reduction in crash rates (Evans, 1991).

It has long been recognized that changes in the driving environment influence drivers' behaviour (Evans, 1991). Also there is evidence that certain aspect of drivers' behaviour such as speed choice (Horswill & Coster, 2002) and car- following distance relate to crash involvement.

Fridstrom and Ingebrigsten (1991) found that extensions and improvements to road network do not have the expected effect of improving safety. They also found that more congested roads lead to fewer casualties.

The road environment on the Accra- Cape Coast highway has improved dramatically since its upgrade in 2003/2004 with the hope that the improved condition will lead to reduction in crashes. Unfortunately, records indicate road crashes and its associated injuries, death and damages are on the increase. On this basis, the study sought to answer the following questions:

- Is there a relationship between availability of vehicle safety devices and risk taking behaviour?
- Does the presence of more vehicle safety devices influence driving behaviour?
- Is there a relationship between the presence of vehicle safety devices and driver's speed choice?

- Has road infrastructure improvement reduced road traffic casualties?

Research Objectives

The main objective of the study was to test the risk compensation hypothesis on the Accra - Cape Coast highway.

The specific objectives were to:

- Ascertain the effect of road infrastructure improvement on road traffic casualties;
- Analyze the relationship between age, gender and driver risk taking behaviour;
- Evaluate the relationship between availability of vehicle safety devices and driver speed choice;
- Evaluate the relationship between availability of vehicle safety devices and driver risk taking behaviour (speed choice and driving violations).

Hypotheses

- H_0: There is no significant relationship between availability of vehicle safety devices and driver risk taking behaviour
- H_1: There is a significant relationship between availability of vehicle safety devices and driver risk taking behaviour.
- $H_{0:}$ There is no significant relationship between age, gender and driver risk taking behaviour.

- $H_{1:}$ There is a significant relationship between age, gender and driver risk taking behaviour.
- H_0: There is no significant relationship between road infrastructure improvement and road traffic casualties.
- H_1: There is a significant relationship between road infrastructure improvement and road traffic casualties.

Justification of the study

The escalating incidence of road crashes in Ghana is no news to Ghanaians. Despite increased road safety campaigns, the rate at which crashes occur on our roads is very alarming. It is an undeniable fact that one of the major challenges that this country is still battling with is motor crashes.

Professor Agyeman Badu Akosah rightly hammered home this fact when he stated that the most 'deadly disease' in Ghana at the moment is motor crashes. In 2001, for example, Ghana was rated as the second highest road traffic crash-prone nation among 6 West African countries, with 73 deaths per 1000 crashes (Mensah, 2008).

Ghana records about 10,000 fatal road traffic crashes every year, out of which 1,600 people perish while 15,000 are seriously injured, robbing the nation of some precious lives. Such persons may die or become incapacitated, denying them the ability to contribute to the nation's development meaningfully (Mensah, 2008).

Questions as to whether, in which manner and to what extent road users alter their behaviour and their crash risk in response to legal, educational and technological intervention and innovations continue to attract a considerable amount of attention. Based on the above revelations, findings from this study will be a major contribution to knowledge. Abane (2010) observed that there has been evidence of the Peltzman hypothesis in the country, although no study has as yet actually been undertaken to test its efficacy. For example, when the Accra – Kumasi and Accra – Cape Coast highways were upgraded in the early 1990s and 2003/5 respectively, numerous crashes were recorded on them, majority of these crashes said to be due to excessive speeding by drivers who reportedly felt very comfortable driving on the roads.

The study would also serve as a platform for further research into the causes of road traffic crashes in Ghana, especially on the Accra - Cape Coast highway. The study outcome will contribute to the understanding of crash causation which is useful information for the development of rational strategies for the promotion of road safety against various criteria- such as safety per kilometre of mobility, per time unit of exposure to road traffic or per head of population (Wilde, 1988).

The study will also be useful to national policy-makers and the general public in that it will help them to understand the magnitude of the problem and also increase their awareness of this phenomenon. In addition, this can be useful for researchers and traffic engineers who have an interest in collecting and analysing traffic crash data.

Organization of the study

The study is organized in six chapters as follows: Chapter One provides an introductory overview of the whole study comprising the statement of the problem and research questions; objectives; justification of the study, and the organization of the study. Chapter Two is a review of the relevant literature on the topic under investigation bringing out all the aspects related to the topic from different sources. Chapter Three highlights the road traffic crash situation in Ghana particularly touching on the cases involving private vehicles on the Accra- Cape Coast highway. Chapter Four focuses on the methods and procedures employed in achieving the objectives of the study and in testing the hypotheses. Chapter Five embodies the analysis, discussion and interpretation of both primary and secondary data. Chapter Six concludes the study by providing summary and conclusion of the study and ends with some recommendations and policy implications.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter is divided into two parts. The first part draws on the enormous literature and empirical works on the topic. The issues highlighted include vehicle safety devices; the effects of vehicle safety devices and road infrastructure improvement on driving behaviour and road traffic crashes. The second part outlines various theoretical perspectives and the conceptual framework for understanding road traffic crashes.

Vehicle safety devices

Automobile is a self-propelled vehicle used primarily on public roads but adaptable to other surfaces. Automobiles changed the world during the 20th century, particularly in the United States and other industrialized nations. From the growth of suburbs to the development of elaborate road and highway systems, the so-called horseless carriage has forever altered the modern landscape.

Automobiles are classified by size, style, number of doors, and intended use. The typical automobile, also called a car, auto, motorcar, and passenger car, has four wheels and can carry up to six people, including a driver. Larger vehicles designed to carry more passengers are called vans, minivans, omnibuses, or buses. Those used to carry cargo are called pickups or trucks, depending on their size and design. Minivans are van-style vehicles built on a passenger car frame that can usually carry up to eight passengers. Sport-utility vehicles, also known as SUVs, are more rugged than passenger cars and are designed for driving in mud (Fetherston, 2008).

Bradsher (2002) defines sport-utility vehicles (SUVs) as vehicles that are based on a truck-like steel chassis, are designed to handle off-road travel, have either standard or optional four-wheel-drive, have an enclosed cargo area, and are marketed to consumers who likely do not intend to use the off-road capabilities. Bradsher (2002) also states that sales of SUVs currently account for approximately 17 percent of new vehicle sales, up from just 1.78 per cent in 1982. It has also been estimated that as much as half of all new vehicles sold in the U.S. market are classified as light trucks.

Manufacturers continue to build lighter vehicles with improved structural rigidity and ability to protect the driver and passengers during collisions. Modern vehicles feature crumple zones, portions of the automobile designed to absorb forces that otherwise would be transmitted to the passenger compartment. Passenger compartments on many vehicles also have reinforced roll bar structures in the roof, in case the vehicle overturns, and protective beams in the doors to help protect passengers from side impacts (Fetherston, 2008).

Electronics is expected to play a major role in crash warning and avoidance technologies in the future. Following the increased level of adoption of ABS, recent times have seen the rate of development of active safety systems increase sharply. Many of these safety systems extend the capabilities of ABS, by taking control of vehicle braking and other inputs away from the driver and applying alternative ("safer") inputs based on predetermined algorithms. Braking based systems include, non- exhaustively, traction control, electronic stability control

(ESP), vehicle stability control systems (VCS), emergency brake assistance and intelligent braking systems (Buxton, 1997).

Anti-Lock Braking System (ABS)

Antilock braking systems (ABS) are closed- loop control devices that prevent wheel lock-up during braking and as a result vehicle stability and steering are maintained. System components include: a wheel- speed sensor, a hydraulic modulator and an Electronic Control Unit (ECU) for signal processing and control and triggering of the signal lamp and of the actuators in the hydraulic modulator (Bauer, Petkova, & Boyadjjewa, 2000). ABS functions by detecting the onset of wheel lock-up, due to a high braking force, and then limiting the braking pressure to prevent wheel lock-up. The ECU recognizes the wheel lock-up as a sharp increase in wheel deceleration. Braking force is reapplied until the onset of wheel lock-up is again detected at which point it again reduces the brake force in a closed loop process. The cyclic application and reduction of braking force ensures that the brakes operate near their most efficient point and maintains steering control. This cyclic application is also responsible for the pulsating that a driver feels through the brake pedal when the system is activated.

Since its introduction, ABS has been acclaimed as providing significant improvement to overall vehicle safety. According to Forkenbrock, Flick and Riley (1998), the principal reason for equipping passenger cars and light trucks with ABS is to increase safety. Track experience and data have shown the benefits of ABS in reducing stopping distances and maintaining steering control. Such results, and not real- world crash data, have driven the assumption that ABS has a positive net safety benefit.

Airbag

An airbag is a vehicle safety device. It is a high-speed inflation device hidden in the hub of the steering wheel or in the dash on the passenger's side. It is an occupant restraint consisting of a flexible envelope designed to inflate rapidly in an automobile collision, to prevent vehicle occupants from striking interior objects such as the steering wheel or window. Some automobiles have side-impact air bags, located in doors or seats. At impact, the bag inflates almost instantaneously. The inflated bag creates a cushion between the occupant and the vehicle's interior.

In head-on collisions, drivers and passengers are thrown forward inside the vehicles. When an air bag is activated, or deployed, it inflates instantly and creates a firm barrier that counters the forward motion of the driver or the front-seat passenger. Air bags are designed to prevent the driver or front-seat passenger from hitting the windshield or dashboard of the vehicle, thereby eliminating injuries or reducing their severity. An air bag is also known as a Supplemental Restraint System (SRS), or a Supplemental Inflatable Restraint (SIR). Air bags are designed to work in conjunction with seat belts. However, an air bag alone can provide some protection for a vehicle occupant who is not wearing a seat belt.

In 2002 over 60 per cent of all vehicles in the United States were equipped with drivers' air bags. The National Highway Traffic and Safety Administration (NHTSA) estimated that by 2002 air bags had saved the lives of over 9,000 people in the United States. Air bags first appeared in the mid-1970s, available as an optional accessory. Today they are installed on all new passenger cars sold in the United States.

Some newer automobile models are equipped with switches to disable the passenger-side air bags when a child or infant is traveling in the passenger seat. Automakers continue to research ways to make air-bag systems less dangerous for frail and small passengers, yet effective in collisions (Fetherston, 2008).

Electronic Stability Control

Electronic stability control (ESC) is an in-vehicle technology whose goal is to help the driver maintain directional control of the vehicle. The system continuously monitors the driver's actions and contrasts it with the behaviour of the vehicle in order to detect an impending Loss of Control (LOC) such as in severe under- and over-steer situations. If an impending LOC is detected, the system reacts within milliseconds and independently applies the brake to the wheels to counteract any under-steer or over-steer. In addition, the system reduces the throttle. The system passively monitors the driver's inputs and vehicle state, activating only during imminent LOC situations. The system does not have any effect on the vehicle or the vehicle's performance during normal driving. Unlike systems such as traction control or Anti-lock Braking System (ABS), where a properly trained driver could conceivably apply the same counter-measures, the independent wheel braking utilized by ESC cannot be applied by the driver alone (Papelis, Watson, & Brown, 2010).

ESC works in conjunction with ABS to ensure that directional control is maintained even under severe braking manoeuvres taking place at high speed. There are several manufacturers that provide ESC as either standard or optional equipment. In all cases, the fundamental operation of the system remains the same, although the name and detailed implementation of the system varies depending on the manufacturer. Some of the names used for these systems are: Electronic Stability Program (ESP), Active Stability Control (ASP), Dynamic Stability Control (DSC), Vehicle Stability Control or Vehicle Skid Control (VSC). Due to its integration with the vehicle, ESC can only be installed by the manufacturer and cannot easily be retrofitted into an existing vehicle. Empirical study of ESC poses several challenges (Papelis et al., 2010).

Because ESC only activates during LOC situations, it is nearly impossible to create controlled and safe situations in which ESC can be assessed with drivers from the general population. Performing tests in a controlled environment such as a test course creates a high risk of collisions, rollovers and other violent manoeuvres that would endanger the participants. Such environments are also limiting because creating realistic and controlled interactions with multiple other vehicles at realistic speeds is difficult, if not impossible. Driving simulation is a unique alternative to safely, ethically and effectively conducting empirical ESC research using the general driving population. A driving simulator provides a safe environment where drivers can be exposed to complex scenarios with minimal risk. Further, drivers can be exposed to repeatable scenarios that maintain consistency allowing for statistical comparisons (Papelis et al., 2010)

Papelis et al. (2010) observed that ESC and its variants have received significant interest, primarily because loss of control is a contributing factor in a large percentage of crashes. Since ESC first appeared in Europe around 1995, several research efforts have assessed the effect of ESC on crash severity and crash risk in Europe. Initially, the effect of ESC on crashes was estimated indirectly, by first calculating the percentage of crashes that involve factors related to loss of control and then applying various reduction estimates to these crashes. According to German safety data, up to 40 per cent of fatal crashes involved loss of control, or have similar root causes that can be addressed by ESC. Analysis of crash data in Sweden indicate that ESC could have a positive effect on 67 per cent of fatal crashes involving loss of control and on 42 per cent of crashes involving injury (Tingvall, Kraff, Kullgren, & Lie, 2003). In Japan, it is estimated that 20 per cent of crashes involving injury and 40 per cent of crashes with fatalities are related to loss of control (Aga & Okada, 2003). Similar results are reported for France (Bar & Page, 2002).

According to the National Highway Traffic Safety Administration (NHTSA, 2004), approximately 38,000 out of a total of 6.3 million crashes each year in the U.S. involve fatalities. Among fatal crashes, 58 per cent are single vehicle crashes that are strongly linked to loss of control with excessive speed being one of the contributing factors. The increased rollover risk for SUVs is another area where ESC has the potential of reducing risk (Wenzel & Ross, 2005).

A more direct assessment of the effectiveness of ESC is through epidemiological studies that compare crash rates on similar populations with and without the system. Using the European Accident Causation Survey (EACS) containing data on 1764 crashes, it was estimated that ESC would either prevent or reduce the severity of 18 per cent of all crashes and 34 per cent of fatal crashes. Furthermore, if the root cause of a crash is loss of control, ESC would have a similar benefit in 42 per cent of injury crashes and 67 per cent of fatal crashes. These data are similar to the estimates reported by Tingvall et al. (2003) and to those reported by Aga and Okada (2003). More recently, a three step analysis of crashes in France shows that ESC-equipped vehicles have a 44 per cent reduction in a loss- of-control crashes when compared to non-ESC equipped vehicle. In the U.S., research has shown that ESC reduces single-vehicle crash involvement risk by 41 per cent and single vehicle injury involvement risk by 41 per cent. More importantly, it is estimated that ESC has the potential of reducing overall fatal crash involvement by 34 per cent (Papelis et al., 2010).

Effect of vehicle safety devices on driving behaviour and road traffic crashes

Recent research indicates that a growing number of motorists are being exposed to aggressive, violent and/or reckless behaviours on public roads. These behaviours are a concern as a considerable body of evidence is now demonstrating a link between aggressive driving violations and increases in the risk of crash involvement. For instance, intentional driving violations have been found to be a significant predictor of involvement in vehicle crashes (Parker, Reason, Nanstead, & Lie, 1995). As a result, a considerable body of research is presently focusing on identifying the causes of aggressive and violent driving behaviours and the subsequent impact these behaviours have on road safety (Davey, Wishart, Freeman, & Watson, 2007).

In-vehicle and simulator research on collision avoidance technologies such as lane departure warnings, adaptive cruise control (ACC), and anti-lock brakes (ABS) have demonstrated the propensity of some drivers to display behavioural adaptation. It follows, then, that some drivers may adapt to the introduction of ESC, which may unnecessarily limit the overall, societal benefits of this technology. For example, drivers of ESC-equipped vehicles may drive faster than conditions allow, follow a lead vehicle more closely, and/or choose to drive in more inclement weather than when driving a vehicle without ESC.

Apart from the 2006 survey (Rudin-Brown & Burns, 2007) there have been no studies that have looked specifically at the potential for ESC to induce behavioural adaptation. Previously, the telephone survey method was used to assess the propensity of drivers to develop behavioural adaptation to another in-vehicle collision avoidance system, antilock brakes, or ABS. Introduced in the mid-1980s, ABS help drivers maintain some steering ability and avoid skidding while braking by preventing individual vehicle wheels from locking up. Results from that study demonstrated that many people mistakenly believed that their own vehicle was equipped with ABS when, in fact, it was not. Further, one in five respondents who were aware of whether or not their vehicles were equipped with ABS incorrectly believed that having ABS permits them to drive faster. Fewer than half of the situations identified by respondents as benefiting from the presence of ABS actually were.

Finally, and of most concern, three out of four drivers incorrectly believed that ABS provide the driver with more control of their vehicle than conventional braking systems on deformable (snow, slush, gravel) surfaces. In actual fact, with

ABS, stopping distances on deformable surfaces are increased significantly compared to conventional brakes. Collectively, the results indicated that conditions existed that would support the development of behavioural adaptation to ABS, at least among those drivers who held inaccurate beliefs regarding the technology (Rudin- Brown, Burns, Jenkins, Whitehead, & LeBlond, 2008).

In recent years, light trucks have begun to account for an increasing percentage of vehicles in the United States as more light trucks are manufactured by both domestic and foreign auto makers. Under traditional categorization by the federal government, light trucks consist of pickup trucks, vans, and sport-utility vehicles, all weighing under 10,000 pounds gross vehicle weight. The mounting concern for vehicle occupant safety has focused on the emergence of light trucks as a substitute for traditional cars, with the primary growth currently in large pickups and sport-utility vehicles.

According to NHTSA, by 1992, there were more fatalities in crashes between cars and light trucks than between cars only, with the vast majority of the fatalities being the car occupants. These concerns continue to grow as larger light trucks are built and sold each year. Light trucks have received more lenient regulations on fuel efficiency, safety standards, and pollution controls, all of which has made them attractive and profitable for auto companies to manufacture. As a result of this government subsidization, light trucks have been marketed to individuals and families with high incomes, a market segment that previously bought large and luxury cars. Auto producers have successfully marketed light trucks as being safer than cars due to their size, weight, and availability of four-wheel drive. However, true safety benefits of light trucks, primarily SUVs, have been questioned by both governments and automotive safety experts because of their propensity to roll over in sudden manoeuvres, difficulty in braking and handling of four-wheel-drive, and the dangers that large vehicles pose to other traffic. Still, it appears that buyers of light trucks are convinced that there is an added safety benefit to operating vehicles that are significantly heavier than cars and have the capability to traverse rough terrain.

Different types of vehicles have very different crash risks associated with them. Grush, Marsh and South (Evans, 1991) provided evidence indicating that when driver fatalities per vehicle were compared for a range of car models, the highest fatality risk was six times the lowest. At least part of this variation is likely to be due to differences in driving behaviour. While differences in driving behaviour may be due to certain drivers choosing certain types of car, it is also conceivable that certain types of car engender driving styles that influence crash risk.

Certain in-vehicle engineering safety features have also been found to be associated with measurable human behaviour feedback. Evans and Gerrish (1996) studied seven General Motor vehicle models in the US where ABS was unavailable during 1991 and fitted as standard equipment in1992. They found that on wet roads ABS reduced the risk of a vehicle crashing into a lead vehicle compared to the risk of being struck from behind by 48 per cent (+/- 6%). ABS reduced the risk of crashing into a lead vehicle by 32 per cent (+/- 14%). Conversely, on dry roads ABS- equipped vehicles were more likely to crash into the rear of vehicles, with an estimated increase of 23 per cent (+/- 15%). This result was unexpected and suggested an increase in risk taking behaviour by ABS drivers (Buxton, 1997).

Evans (1998) suggested that ABS may be associated with a small change in driver behaviour, which increases crash risk. Yamamoto and Kimura (1996) analysed human behaviour in an attempt to determine the cause of increased rollover crashes involving ABS-equipped vehicles. A sample of 38 drivers was tested in emergency situations on a test track, and the drivers' behaviour was summarized as follows:

- Drivers do not press the brake pedal simultaneously with steering
- At higher vehicle speeds, drivers concentrate more on steering than braking,
- Drivers make mistakes in operation.

Yamamoto and Kimura (1996) argued that the increase in rollovers was not due to the characteristics of ABS, but either to drivers who become aggressive in their behaviour, relying too much on ABS to prevent crashes, or their inability to operate the ABS correctly. To describe the ABS anomaly Evans (1998) later put forward two postulates, based on anecdotal information:

- Drivers never drive more slowly when their vehicles have ABS
- Some drivers, under certain circumstances, tend to drive a little faster because their vehicles have ABS.

Gibson and Crooks (Evans, 1998) describe the theory whereby a driver adapts their driving as a result of a new safety measure, such that the safety benefit of any improved performance may be reduced. In regard to vehicle braking, Gibson and Crooks state "More efficient brakes on an automobile will not in themselves make driving the automobile any safer. Better brakes will reduce the absolute size of the minimum stopping zone, it is true, but the driver soon learns this new zone and, since it is his field-zone ratio which remains constant, he allows only the same relative margin between field and zone as before" (Buxton, 1997).

Evans (1998) notes that research does not support the suggestion that improved braking cannot affect overall crash risk. However, technical innovations that lead to observable differences in vehicle performance or handling characteristics are likely to be accompanied by changes in driver behaviour.

It is worth noting that not all in-vehicle safety features are associated with significant human behaviour feedback. For example, Evans (1991) reviewed evidence indicating that seat belts are an example of safety feature where human behaviour feedback is close to zero, such that the expected safety increases match actual safety increases.

Traffic crash records also indicate that certain vehicle types are over represented in number of crashes as compared to other vehicle types. Bener (2001), for instance, reported that four- wheelers are associated with frequent crashes and severe casualties and fatalities in United Arab Emirates. In addition, four-wheelers constituted 35 per cent of fatal crash -involved drivers in Qatar in 2004. On the other hand, when involved in an accident, 4WD vehicles sustain significantly less damage and their occupants are less severely injured and/or killed than those of vehicles of medium and standard size and other road users (Bener, Al Maadid, Ozkan, Al-Bast, Diyab, & Lajunen, 2008).

Human factors in driving can be seen as being composed of two separate components, driving skills and driving style (Elander, West, & French, 1993). Driving style concerns individual driving habits, that is, the way a driver chooses to drive. It can be supposed that, therefore, four- wheel drivers should have different driving style as compared to other driver groups, that is, small car users. However, the impact of 4WD vehicles on self-reported risky driver behaviours has not been investigated before. In addition, socio- demographical and behavioural factors related to crash involvement of 4WD vehicles have still remained unexamined.

One of the most widely used instruments for measuring aberrant driver behaviours is the Driver Behaviour Questionnaire (DBQ). DBQ makes the distinction between violations and errors. Violations referred to ‘‘deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system” (Reason, Manstead, Stradling, Baxter, & Campbell, 1990). Violations were later classified as aggressive and ordinary ones (Lawton, Parker, & Stradling, 1997). The former involves overtly aggressive acts; the latter consists of deliberately breaking the Highway Code and/or the law without aggressive motives. Errors were defined as a ‘‘failure of planned actions to achieve their intended consequences that can involve the unwitting deviation of action from intention (slips and lapses) or departure of planned actions from some satisfactory path toward a desired goal (mistakes)” (Reason et al., 1990). The theoretical four-factor structure of the DBQ has also been found in different samples and in several countries by self-reported measures.

A recent study on risk taking attitudes and risky driving behaviour revealed that attitude toward rule violations and speeding was the strongest predictor of behaviour (Iversen, 2004). In addition, it can be assumed that physical size of the vehicle and engine size of four-wheel vehicle might influence risky driving behaviours and/or ignorance of safety concerns. As it has been found in the previous studies, the results of the present study also showed that four- wheelers are also less vulnerable to injuries, probably because of the physical size and quality. This might give an illusion of safety and driving in a ‘‘safe box” for four-wheelers. It can also be reason for not wearing a seat belt, which is common habit among four- wheelers. Four-wheel vehicles have stronger engine than small cars.

Higher vehicle acceleration has been found to lead to drivers pulling out into smaller gaps in front of oncoming vehicles thereby negating much, but not all, of the safety benefit of the increased accleration (Evans & Herman, 1976). Wasielewski and Evans (1985) reported that drivers of 900 kilogram cars who were involved in a serious crash were 160 per cent more likely to be killed than drivers of 1800 kilogram cars were. However, the number of car occupants killed in the lighter cars, per registered car, was only 70 per cent higher than the number killed in the heavier cars. They argued that this discrepancy could be accounted for by their additional finding that drivers of heavy cars drive faster and follow the vehicle in front more closely.

There are a number of studies that have examined the effect of different vehicle characteristics on drivers' behaviour. Horswill and Coster (2002) reported an experiment in which drivers in a video simulation chose faster speeds when the level of internal car noise was reduced. This was demonstrated not to be due to drivers' perception of the capacity of the vehicle, as the manipulation was significant even at slow speeds.

Horswill and Coster (2002) examined the link between auditory information, speed estimation, and vehicle type. They found that the drivers of small cars could estimate speeds more accurately than the drivers of large cars could. They indicated that this effect was at least partly as a result of auditory cues, because when the hearing of the drivers was attenuated, the speed estimation accuracy of the drivers of small cars decreased more than the drivers of large cars did. This was thought to be because the drivers of large cars had very few auditory cues in the first place.

The potential effects of human behaviour feedback are often overlooked when road safety changes are recommended. In Norway, for example, policies that promote the sale on new cars have been considered, as modern cars have more sophisticated safety features than older vehicles (Fosser & Christensen, 1998). However, Fosser and Christensen (1998) found that the newer the vehicle, the higher the probability of both damage-only and injury crashes, when driver mileage, age, gender and region have been controlled for. They suggested that this was because newer cars fostered more risky behaviour, which counteracted the benefit from the improved safety features.

Effect of road infrastructure improvement on driving behaviour and road traffic crashes

The upgrading of road infrastructure has normally been seen as a technique for reducing fatalities and injuries associated with traffic crashes. Historical trends would tend to support this viewpoint as fatalities per mile travelled have declined substantially over the last 30-40 years in the United States. Conventional traffic engineering would not question the assumption that “safer” and newer roads reduce fatalities. However, this type of approach tends to ignore behavioral reactions to safety improvements that may off-set fatality reduction goals (Noland, 2002). For example, if a two lane road is expanded to four lanes this could potentially reduce the risk of head-on collisions but may also result in many drivers travelling at higher speeds, potentially leading to no gains in safety.

The most common way of adjusting road design to a particular level of speed has been through design standards, by choosing a design speed and using it in calculating horizontal and vertical curves, the minimum stopping sight distance and the passing sight distance. Geometric design standards, and the assumptions on which they are based, have evolved in order to provide more homogeneous designs and in particular to introduce safety as an explicit criterion in relation to the chosen design speed.

Much research in highway safety and the relationship to infrastructure (or geometric design) has focused on specific design elements and attempts to quantify their crash reduction potential (Transportation Research Board, 1987). The Transportation Research Board (1987) evaluated much of the existing literature and modelling efforts to develop crash reduction factors. Various gaps in knowledge were identified but the report generally concluded that new and better design standards were leading to safety improvements. Relevant roadway characteristics are geometry, surface condition, shoulder and median width, and lane width (Unrau, 2004).

A commonly cited example is the finding that when roads have been widened in order to increase their safety drivers' speeds often increase as a result, with the net effect of negating any overall increase in safety. Also, it is a well-documented finding that as lane width and road width increase, drivers' speeds also increase and their lane positions move closer to the road edge. These behavioural changes do potentially negate any safety gain produced by wider roads (Lewis- Evans & Charlton, 2006)

Milton and Mannering (1998) find similar results using data from the state of Washington. While they find that increased average annual daily traffic leads to an increase in crashes, they also find that when the percent of this traffic at the peak increases, then crashes decrease. They also examine various geometric design elements for principal arterials. They find that increasing the number of lanes on a given road segment leads to more crashes and that in Eastern Washington, narrower "substandard" lane widths (of less than 3.5 metres or 11.5 ft) reduce crash frequency. Vitalino and Held (1991), also find that more lanes lead to more crashes. In another development Sawalha and Sayed (2001) also observed an association between the number of lanes and increased crashes on arterials.

Shankar, Mannering and Barfield (1995) estimated a series of negative binomial regression models in a study of the Interstate 91 corridor in Washington State. They found that when curves are spaced further apart (i.e., fewer curves per mile) there is an increase in more severe overturning crashes. This same study also found that highway segments that have curves with lower design speeds result in fewer crashes relative to those with higher design speeds; though the presence of snowfall tended to increase crashes on those segments with curves of lower design speeds. They also found that those crashes attributable to curves of lower design speeds tended to be less severe than those associated with curves of higher design speeds.

Council and Stewart (1999) analysed the safety effects of converting two lane rural roads to either four lane divided roads or four lane undivided roads. They found some significant reduction in crashes for the conversion to divided roads but less significant results for undivided roads. They consider their research preliminary and inconclusive; however, it does suggest that while specific improvements such as separating lanes (or installing medians) may be relatively effective, merely adding more lanes is not.

To a large extent the idea that both increased capacity and infrastructure improvements may lead to increased risk can be explained by behavioural responses from drivers. Many infrastructure improvements tend to make the driving task less taxing such that the driver may reduce the level of concentration needed to maintain the same level of safety.

Mahalel and Szternfeld (1986) hypothesized that improved engineering standards influence driver perceptions due to simplification of the driving task, resulting in an underestimation of the difficulties of the driving task. The net result could be an increase in crashes. They provide some illustrative examples of how this could occur. Most road improvements also allow greater speeds. This could be another underlying factor that explains the results that are found. Some of the behavioural responses discussed in the literature on risk compensation (Peltzman, 1975) and risk homeostasis (Wilde, 1982) touch on these issues (Noland, 2002).

Width, gradient, alignment and layout and their consistency are important determinants of speed choice on a particular stretch of road. They affect not only what is physically possible for a given vehicle, but also what seems appropriate to a driver. The latter is also affected by the surroundings of the road, especially the closeness of tall objects such as trees and buildings, through the rate of stimulation of peripheral vision. Some aspects of the standard of maintenance of the road are evident enough to drivers to affect speed choice, but other aspects that make lower speeds appropriate are not obvious to drivers. Many journeys include transitions from a stretch of road where higher speeds are appropriate to another stretch where the appropriate speed is much lower, such as driving from a motorway on to a single-carriageway rural road or entering a village from open country. Design of the road and its surroundings can help drivers to make these transitions safely (Lewis- Evans & Charlton, 2006).

It is often thought that the geometric characteristics of a motorway affect drivers' choices of speed. In reality, however, there is no strong relationship between geometric design and the speeds chosen by drivers on motorways. Curves and narrow lanes have some downward influence on chosen speeds, but the net effect of each on safety is negative. In particular, tight curves are the reason for many crashes, particularly single vehicle crashes. There is thus no known way in which infrastructure design can be used to reduce inappropriately high speeds on high quality high speed roads without being counter-productive to safety (European Transport Safety Council, 1995). The review also found that road improvements, particularly widening schemes, when they are not combined with safety measures, may increase crashes.

Age, gender and driver risk taking behaviour

Differences between men and women in terms of their driving behaviour and crash rates have long been demonstrated in the United Kingdom, mainland Europe, the United States, Australia and in many other countries. In all studies and analyses, without exception, men have been shown to have a higher rate of crashes than women. This gender difference is most marked in the population under the age of 25 years, but is also evident among older drivers. The difference between the sexes in terms of the number of fatalities resulting from road crashes is similarly marked.

The scale of this difference between the sexes is very substantial. Chipman, MacGregor, Smiley and Lee-Gosselin (1992), for example, show that men have double the number of crashes (per 1,000 drivers) than women. Waller, Elliot, Shope, Raghunathan and Little (2001) also noted that in addition to having a higher number of crashes, men incur their first crash earlier in their driving career and are more likely than women to be held to blame for the incident. Norris, Matthews and Riad (2000) attribute this greater level of crash-proneness to higher driving speeds among men and less regard for traffic laws.

Waylen and McKenna (2002) noted that the pattern of road crash involvement also differs between the sexes. Men are more likely than women to be involved in crashes that occur on bends, in the dark or those that involve overtaking. Women, on the other hand, have a greater frequency of crashes occurring at junctions than men. This supports the suggestion by Storie (1977) that men are more at risk from crashes involving high speed while women are more likely to be involved in crashes resulting from perceptual judgement errors.

A study by Lajunen and Parker (2001) used self reports of subjects' levels of aggressive driving and found significant gender and age effects. Among men, aggressive driving was most associated with the lower age groups. Among women, however, age was a much less significant factor. Stradling and Meadows (1999) report that while aggressive driving in males does, indeed, decline with age, the levels are greater than those for females in all age categories. They also observed that male drivers are not only more likely to drive faster; they are also more likely to commit a range of driving violations. A number of other studies confirm these consistent findings. For example, Parker and Stradling (1998) found that in the United Kingdom, 40 per cent of male drivers could be classed as 'high violators', compared with 20 per cent of female drivers. Violations included such behaviours as jumping red lights, driving close to the vehicle in front, driving over the legal limit for blood alcohol, being involved in unofficial races with other drivers as well as exceeding speed limits. For speeding, they found, on the basis of national surveys of drivers, that twice the number of males had been stopped by the police for speeding compared with females. When presented with the statement 'I disregard the speed limits late at night or very early in the morning', 22 per cent of male drivers agreed with the statement, compared with only 8 per cent of females.

Extensive support for such findings exists in other studies (Reason et al., 1990). In addition to speeding and other driving violations, males, and young males in particular, are the most likely group to drive after drinking (Caetano and Clark, 2000). A study by Yagil (1998) in Israel, conducted among university students, indicated that females had a stronger sense of obligation to obey traffic laws. They were also more likely to evaluate traffic laws positively. The observed gender differences were particularly pronounced among young drivers. Women were more likely than men to view the content of traffic laws as important, clear and reasonable. This resulted in a stronger sense of obligation to obey traffic laws. Women reported that they would comply with traffic laws even in situations where non-compliance was not perceived as risky. Men, on the other hand, tended to overestimate their driving ability and feel more confident in complying selectively with traffic laws. Young males in particular were more likely to evaluate traffic laws negatively and to underestimate the risks associated with traffic violations.

Theoretical perspectives

A number of theoretical frameworks have been suggested for studies on crash risk. Among the most widely quoted is Peltzman's (1975) Risk Compensation Hypothesis which argues that improvement in safety devices in vehicles (e.g. airbags, dual braking systems, etc.) as well as road improvements originally designed to ensure safety invariably serve as incentives to drivers to speed and expose themselves to the risk of crashes. The model has been extensively tested in studies with mixed results (Abane, 2004).

One thing that is clear, however, is the fact that the majority of drivers will seize on every opportunity to go faster when the road environment is perceived to be good. This behaviour defeats the principle behind creating such good road infrastructure (Abane, 2004)

Another conceptual framework that has been extensively quoted in the literature is the expanded hierarchical model of Keskinen (1996). The underlying principle of the model is that every driver must be able to compose himself or herself even as they control the vehicle and the traffic environment. A good driver should be able to articulate his/ her skills correctly and avoid risks on the road, irrespective of the type of road environment (Abane, 2004).

According to the model, four levels in the hierarchy of driving exist based on experiences from the field. These are (1) the 'vehicle manoeuvring' level characterized by such activities as controlling of speed, directing the vehicle and orientating it within the existing acceptable driving environment; (2) 'mastering traffic situations' where the driver is expected to tune his/ her behaviour to the dictates of prevailing traffic regulations; (3) 'goals and context of driving' which spells out the circumstances under which one should drive; and (4) the 'goals for life and skills for living' level where the driver is expected to have understood the importance of vehicles and driving as components of one's development. The level recognizes skills acquired as one goes through the levels and sees these skills as promoting in the driver some degree of self- control and self- confidence.

The importance of this model lies in its capacity to pigeon-hole drivers into categories based on their levels of competence and experience. Its weakness is however in the failure to recognize the relationship between risk and the background of drivers. The assumption that once a driver reaches the fourth hierarchy he/ she takes driving as part of life seems to play down the level of crash risk associated with driving irrespective of age and experiences (Abane, 2004).

Many other crash studies have adopted mathematical and statistical approaches such as logistic regression and factor analysis to isolate variables considered as most crucial in explaining geographically or otherwise the occurrence of crashes. Some have applied risk models to determine drivers' levels of crashes (Abdel-Aty & Abdelwahab, 2000). These provide very useful lessons but it has to be said that the application of some rigorous mathematical models sometimes lead to loss of some vital information, especially when such data are transformed into symbols and units as though the reality of the world was in a socio-political vacuum (Abane, 2004).

Wilde (1988) proposed the Risk Homeostasis Theory (RHT) to help in the understanding of road traffic crash causation. The theory was originally conceived in an effort to explain various features of crash statistics and other observations in the domain of transportation risk, although it can readily be extended to the area of occupational safety and public health insofar as it depends on lifestyle. It should be emphasized that this theory attempts to explain the crash rate per head of population, not the occurrence of specific individual crashes, nor their immediate and material causes, such as errors of perception, decision or execution.

The theory of risk homeostasis posits that at any moment of time, road users monitor the level of crash risk to which they feel exposed and compare this level with the degree of danger they are willing to accept. This preferred or target level of risk depends on their perception of the advantages and disadvantages accruing from their amount and manner of mobility. The actions taken to keep 'experienced' risk in balance with 'preferred' risk carry an objective likelihood of crash. The actual crash loss incurred by a jurisdiction is the consequence of these actions. This loss, in conjunction with everyday experiences of risk, influences the perceived level of risk among road users who have had no fatal crash. Thus, crash loss and the degree of caution displayed in road-user behaviour are related to one another in a compensatory process, and only those crash countermeasures that are effective in decreasing the preferred level of risk can reduce the crash loss per capita (Wilde, 1988).

Conceptual framework for the study

Yet another framework which has gained currency in the area of road safety is the ecological model suggested by Meade, Florin and Gesler (1988) and modified for crash studies by Jorgensen and Abane (1999). In the model, crashes are considered as a function of three interacting factors, namely the environment, the vehicle and humans. The environment refers to the physical aspects of the transport system such as the road conditions as well as other various infrastructure provided to facilitate driving. The vehicle, on the other hand, refers to all technical components of the car, bus or track designed to enable it to function properly. Any faults could lead to a malfunctioning of the vehicle and expose its user to various risks including crashes. The human aspects relate to all users of modes of transport. Their behaviour, attitudes, perceptions, beliefs and value systems as well as their ages and gender are all important in explaining how they drive a vehicle or walk on a road and the extent to which these in turn expose them to crash risk.

Integrated in this model is a system of traffic highway codes and enforcement designed to ensure that the population adheres to the controls and regulations for maintaining road safety. Implicit in the model is also a structural element linked to the type of society, lifestyles and socio-cultural contexts, which may provide a deeper understanding of traffic risks. Trends in society will also influence traffic safety level and these aspects have to be considered in a field situation.

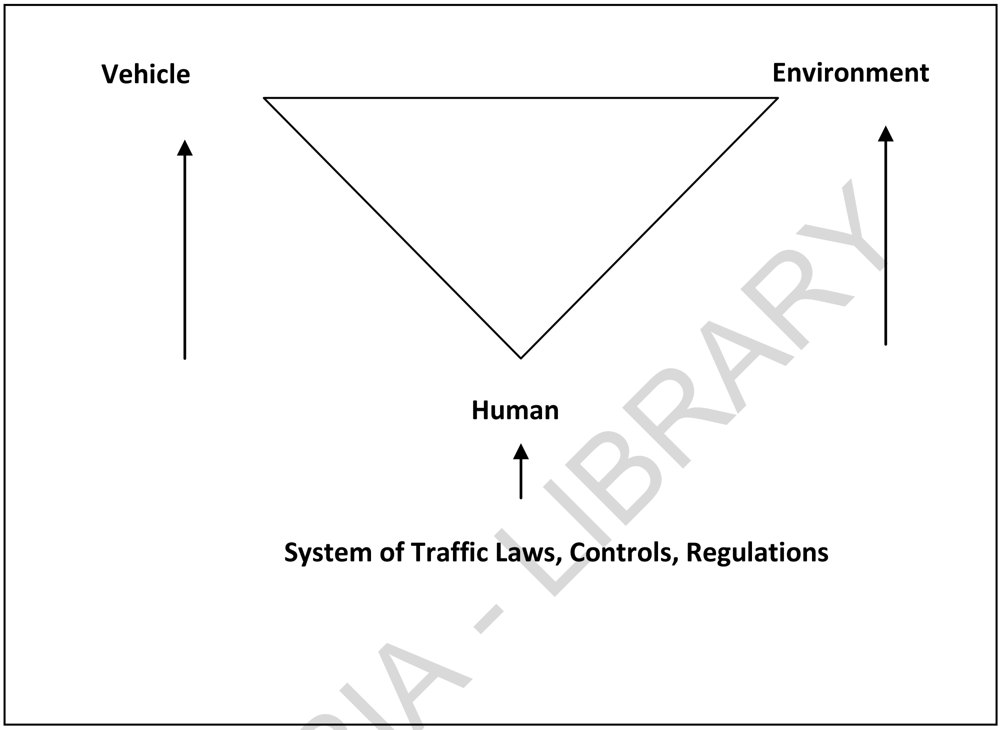


Figure 1: Jorgensen and Abane model for road traffic accidents

Source: Adopted from Jorgensen & Abane, 1999

For the purposes of this study, the model would be operationalised as follows:

- Environment: the road which facilitates driving, in this case the Accra-Cape Coast highway
- Vehicle: safety devices built into the car which provide safety and security for its occupants especially in times of crash and
- Human: the risk taking behaviour (speed choice, drunk driving, tailgating) which drivers exhibit on the road which can result in road crashes.

CHAPTER THREE

ROAD TRAFFIC CRASH SITUATION IN GHANA

Introduction

This chapter outlines the road safety situation as it pertains in Ghana. It dwells on the road traffic crash incidence in the country as a whole, the situation in Central Region and ends with an analysis of data on the crash situation on the Accra- Cape Coast highway which is the focus of this study.

Background of the situation

In almost all countries in Africa, Asia and Latin America, road traffic crashes have become one of the leading causes of death in older children and economically active adults between the ages of 30 and 49 years (Afukaar, Antwi, & Ofosu-Amaah, 2003). Despite this burgeoning problem little attention has been paid to road traffic injury prevention and treatment in most developing countries. Efforts to combat the problem of injuries have, in most cases, been hampered by paucity of funds and lack of relevant data.

In Ghana, attempts have been made in recent years to strengthen the systems for road safety and trauma care. Studies have been carried out during the last decade to gain a better understanding of the nature of the road safety problems, their overall societal burden and the appropriate measures needed to stem the ever-increasing trend in road crashes (Afukaar et al., 2003).

In Ghana, road traffic crashes now rank among the top eight killers and could easily get to the top five within the present decade if no serious effort is made to reduce the current rate of occurrence (Abane, 2004). Crashes have been increasing throughout the country since 2007, claiming at least 6000 lives and causing injury to almost 40,000 people. From 2007 to 2010, a total of 6,213 lives had been lost while 39,797 others had sustained various degrees of injury in motor crashes.

According to records compiled by the MTTU, 1,760 people died while 11,147 people were injured in 12,981 motor crashes involving 18,589 vehicles in 2010. In 2009, 12,565 crashes involving 17,409 vehicles were recorded as having claimed 1,587 lives and caused injuries to 9,767 people. Whereas 1,520 deaths and 7,433 injuries were recorded in 2008, 1,346 deaths and 11,450 injuries were registered in 2007. As many as 71,102 vehicles were damaged in crashes from 2007 to 2010 (Asare, 2011).

The number of motor vehicles in Ghana is increasing rapidly and, coupled with population growth, is contributing to a rise in the number of road traffic injuries and fatalities. Road crashes kill an average of four persons daily in Ghana. In 2005, the number of road crashes increased by 16 per cent relative to 2004. Five regions including Ashanti, Eastern, Gt. Accra, Central, and Brong Ahafo account for more than 70 per cent of the total number of crash fatalities. Some 70 per cent of crashes occur on flat and straight roads. Speeding is a major cause of crashes, accounting for over 50 per cent of reported crashes. Buses and mini-buses cause 35 per cent of fatal crashes while cars are responsible for 32 per cent. Road users between 16-45 years are the most vulnerable group and account for 58 per cent of total road crash fatalities from 2002-2005. Seventy percent (70%) of persons killed in road crashes are males. The age groups from 0-5, 46-65 and over 65 years also accounted for 20.8 per cent, 16.7 per cent and 4.6 per cent respectively of the total fatalities during the same period.

Road crashes with its related consequences in terms of fatalities and injuries are still on the ascendency in the country amidst the various strategies in place to bring the situation to normalcy (see Afukaar et al., 2003). Table 1 shows the distribution of road traffic crashes by region for the year 2009. The data as presented below show that the majority of road crashes still occurred in the Greater Accra region (5,588 reported cases) which represent 45.6 per cent of the total crashes for the year; followed by the Ashanti region (16.1%, n = 1,971) and Eastern region (10.6%, n = 1,304). These three regions accounted for more than half (72.3%) of all reported road crashes in the country.

In terms of the fatalities (persons killed) as a result of the crashes, the three regions - Greater-Accra (19.2%), Ashanti (20.9%) and Eastern (15.3%) - accounted for 55.4 per cent of all persons killed. They as well accounted for 63.2 per cent of all road traffic injuries. Afukaar et al. (2003) provided a simple reason to buttress the trend of road crashes as presented above. According to them, 65-70 per cent of the socio-economic activities and registered vehicles in Ghana are located in these three regions alone. In addition, the road corridor linking Kumasi-Accra-Tema generates the heaviest traffic compared with the Coastal and Northern road corridors.

Table 1: Distribution of road traffic crashes by region (2009)

Region	No. of cases	Persons killed	Persons injured
Ashanti	1,971	469	3,194
Eastern	1,304	343	2,554
Greater- Accra	5,588	429	4,542
Central	917	246	1,616
Brong Ahafo	693	259	1,279
Volta	554	140	1,015
Western	836	144	1,399
Northern	220	113	411
Upper East	119	54	145
Upper West	61	40	104
Total	12,263	2,237	16,259
Total (2008)	11,214	1,938	14,531

Source: NRSC, 2010

Road crashes are a serious social and economic problem. Politicians and others interested in road safety often advocate a change to road users' attitudes as a necessary condition for the improvement of road safety; some consider this a panacea to the road crash problem. Efforts have been made to change the attitudes of road users, e.g. by public information campaigns and driver education. Such measures have so far had limited success in terms of reducing crashes (Assum, 1997).

Crash situation in Central Region

The road traffic crash incidence in the Central Region experienced a pendulum posture especially with respect to the years 2009 and 2010. Table 2 shows recent trends in road traffic crashes, deaths and injuries. The number of reported crashes increased by 58.3 per cent between the first quarters of 2009 and 2010. The period also saw an increase in the number of persons injured (69.3%) as a result of these crashes. However, although there was a tremendous increase in the number of serious cases reported (142.5%); there was a reduction of 32.8 per cent in the number of persons killed as a result. During the same period, the number of vehicles involved in crashes increased by 30.6 per cent. The crash situation for the second quarters of 2009 and 2010 as indicated on Table 3 was not different from the previous situation (first quarters of 2009 & 2010).

Table 2: Road Traffic Crash Statistics for Central Region for the First Quarter of 2009 and 2010

Quarter	Total no. of reported cases	No. of vehicles involved	Fatal cases	Serious cases	Slight/ minor cases	Persons killed	Persons injured
First quarter 2010	300	337	37	97	166	45	259
First quarter 2009	195	258	34	40	121	67	153
Difference	105	79	3	57	45	-22	106
% change	53.8	30.6	8.8	142.5	37.2	-32.8	69.3

Source: NRSC, Cape Coast, 2010

As has become the norm, the number of reported cases saw an increase of 92.3 per cent over the periods in question. More fatal crashes (100%) were witnessed resulting in 65.5 per cent increase in the number of persons killed over the periods in question. The number of vehicles involved in crash also increased by 53.3 per cent.

Table 4 shows the crash situation in the Central Region during the third quarters of 2009 and 2010. The statistics indicated a marked reduction in the crash incidence over the periods in comparison.

Table 3: Road Traffic Crash Statistics for Central Region for the Second Quarter of 2009 and 2010

Quarter	Reported cases	No. of vehicles involved	Fatal cases	Serious cases	Slight/ minor cases	Persons killed	Persons injured
Second quarter 2010	352	394	44	81	227	48	233
Second quarter 2009	183	257	22	71	90	29	204
Difference	169	137	22	10	137	19	29
% change	92.3	53.3	100.0	14.1	152.2	65.5	14.2

Source: NRSC, Cape Coast, 2010

Although 255 crash cases were reported in the third quarter of 2010, this represented only 0.4 per cent increase relative to the third quarter of 2009. During this same period, there were massive reductions in the number of persons killed (52.1%); persons injured (20.8%) and vehicles involved (0.9%).

Table 4: Road Traffic Crash statistics for Central Region for the Third Quarter of 2009 and 2010

Quarter	Reported cases	No. of vehicles involved	Fatal cases	Serious cases	Slight/ minor cases	Persons killed	Persons injured
Third quarter 2010	255	314	20	92	143	23	217
Third quarter 2009	254	317	27	84	143	48	274
Difference	1	-3	-7	8	0	-25	-57
% change	0.4	-0.9	-25.9	9.5	0.0	-52.1	-20.8

Source: NRSC, Cape Coast, 2010

Crash incidence on the Accra- Cape Coast highway

The crash fatalities on the Accra- Cape Coast highway witnessed ups and downs during the period 2004- 2009 in terms of the number of fatal cases, cases where victims were hospitalised, victims injured but not hospitalised and cases involving property damage only.

A look at Table 5 shows that generally the year 2005 recorded a reduction in almost all crash fatalities. Out of 421 cases reported on the highway (representing 13.5% reduction relative to 2004), 59 were fatal; 85 cases were associated with victims being hospitalised; 137 were injured but not hospitalised while 140 cases were associated with property damage only.

However, there was a 17.9 per cent increase in the number of cases reported in 2006 over the previous year (2005). This resulted in an increase in the number of fatalities as indicated on Table 5.

In 2009, 596 cases were recorded and this can be broken down as follows: fatal cases increased by 16 per cent relative to 2008; the number of victims hospitalised also increased by 6.2 per cent and the number of injured but not hospitalised saw 56.6 per cent increment over the previous year. Cases associated with property damage also increased by 5.5 per cent.

Table 5: Crash severity on the Accra- Cape Coast highway from 2004- 2009

Year	Fatal	Hospitalised	Injured (not hospitalised)	Damage only	Total
2004	65	105	141	186	497
2005	59	85	137	140	421
2006	97	135	153	174	559
2007	112	110	123	201	546
2008	94	97	122	183	496
2009	109	103	191	193	596
Total	536	635	867	1077	3115

Source: BRRI, 2010

Table 6 presents the crash fatalities on the highway by the days of the week. Generally, majority of the crash incidence happened over the weekends (Friday to Sunday) during 2004- 2009. On the whole, Saturdays recorded the highest crash incidence (611 cases) among the days of the week; associated with 106 fatal cases; 106 cases were such that victims were hospitalised and 169 cases involved people being injured but not hospitalised. Also cases involving property damage was 230; which happened to be the highest over the period in consideration (2004- 2009).

Table 6: Crash severity by the day of the week

Crash severity	Day of the week						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Fatal	68	73	48	71	84	106	86
Hospitalized	98	85	95	62	88	106	101
Injured not hospitalized	118	125	94	105	130	169	126
Damage not injured	139	147	145	145	136	230	135
Total	423	430	382	383	438	611	448

Source: BRRI, 2010

Moreover, available data also indicate that 62 fatal cases occurred during the time period of 7pm – 8pm; 71 cases where victims were injured but not hospitalised occurred between 7pm and 8pm whilst 77 cases involving property damage happened between 5pm and 6pm on the highway (BRRI, 2010).

CHAPTER FOUR

METHODOLOGY

Introduction

This chapter outlines the study area, research design, target population and issues of sampling and data collection techniques. It also presents challenges encountered in the field during the period of data collection.

Study area

The study was conducted on the Accra-Cape Coast highway. The highway is one of the major national roads (N1 road) linking various towns and villages. It stretches from Asemasa in the Western Region and ends at Kasoa. It is 150.25 kilometres in length with a total surface width of 11 metres (made up of the standard 7.3 metres surface area used by vehicles and 4 metres shoulder width).

The surface layout is asphaltic concrete and made up of a number of road lane markings- continuous, guiding and warning lines. The highway has 13 curves and dual carriage lanes. Surrounding vegetation is mainly grassland and scrub with scanty and isolated trees. The surrounding landscape is generally low lying interspersed with valleys. The road passes through a number of towns and villages including Cape Coast, Yamoransa junction, Mankessim, Esuehyia, Winneba junction and also Kasoa.

The Accra - Cape Coast highway (Figure 2) has in recent times become one of the country's major 'death traps' in terms of vehicular crashes, due mainly to the unacceptable behaviour of drivers who perceive the good surface condition of the trunk road as an opportunity to speed excessively, exposing themselves and their passengers to the risk of crashes (Abane, 2010).

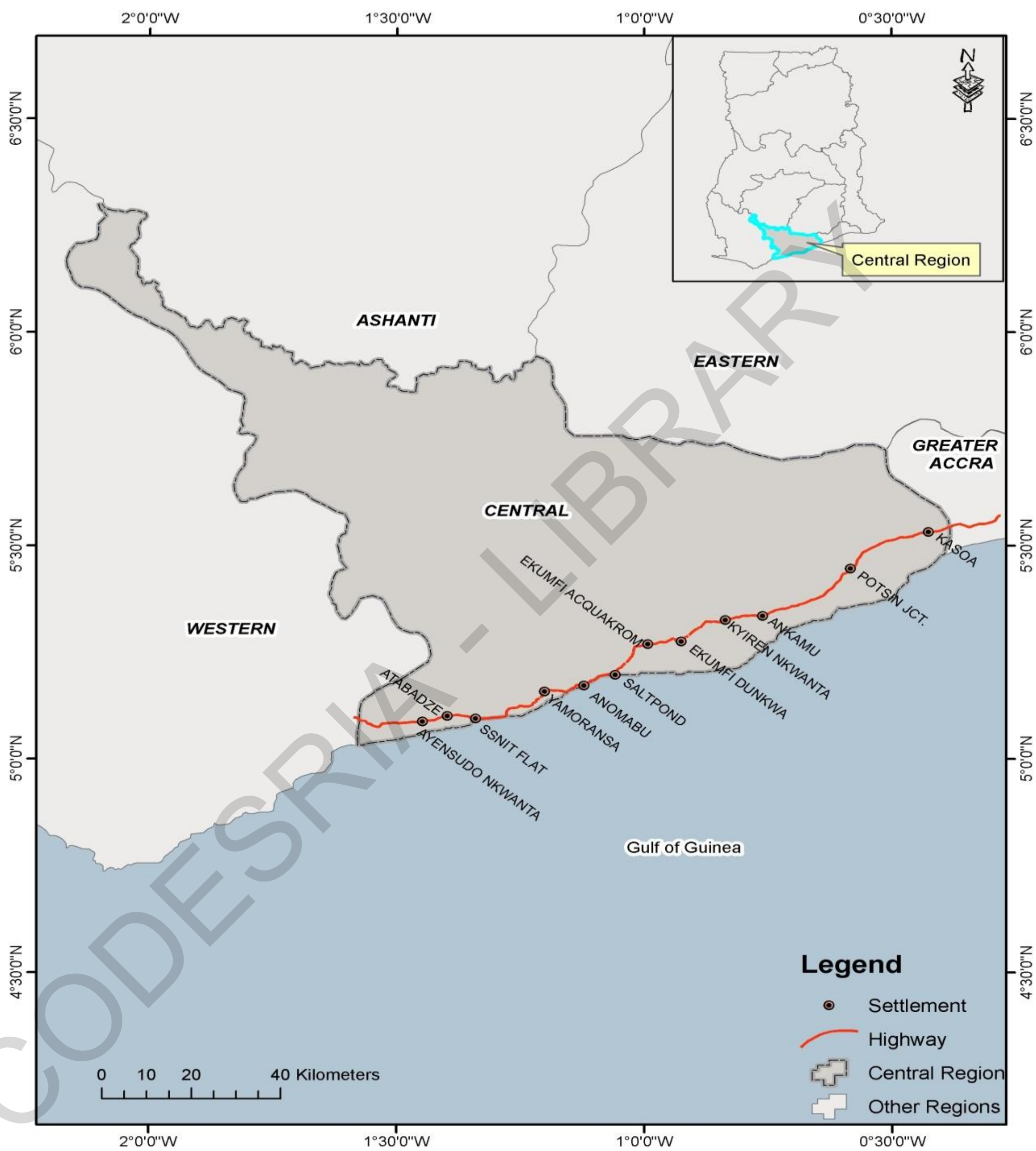


Figure 2: Map showing Accra - Cape Coast Highway

Source: Dept of Geography and Regional Planning Cartography Unit, University of Cape Coast, 2011

Research design

The study adopted a mixed methods approach combining aspects of the qualitative and quantitative research design. Massey (2003) suggested that multiple methods approach represents a poly-vocal approach to research, where employing a range of methodological strategies means that the researcher does not focus on only one side of the social world.

Neuman (2003) has also supported the use of mixed methods technique. According to him, combining different methods in a study is the best because it is better to look at something from several angles than to look at it from only one way. Bryman (2004) has proposed three approaches of the mixed methods technique, namely triangulation, facilitation and complementarity.

The study employed triangulation to facilitate and enhance the field work. Decrop (1999) identifies four basic forms of triangulation: the data, method, investigator, and theoretical triangulations. Specifically the study employed data and methodological triangulation techniques. According to Easterby-Smith, Thorpe and Lowe (1991), data triangulation is the collection of data from different sources in a study of a phenomenon. Data for the study was collected from different sources (Drivers, Motor Traffic and Transport Unit (MTTU), National Road Safety Commission (NRSC) and Building and Road Research Institute (BRRI) of the Council for Scientific and Industrial Research (CSIR) based in Kumasi.

Concerning methodological triangulation, Easterby-Smith et al. (1991) further elaborated that it involves using different methods to collect data for a study. Both observation (qualitative method) and questionnaire administration (quantitative method) were employed in the data collection process.

The mixed methods technique was used based on the distinctive advantage it offers. It helped the researcher gain better understanding of the phenomenon under study and also helped complement the strength of qualitative and quantitative methods. Decrop (1999) has observed that mixed methods open the way for richer and potentially more valid interpretations.

Sources and types of data

The study made use of both primary and secondary data. Primary data was collected using observation and questionnaire administration. The questionnaire administration was used to sample the views and attitudes of respondents (drivers) on the topic as well as their response (behavioural adaptation/feedback) to improved road condition and vehicle characteristics (safety devices). Direct observation was done based on a checklist (appendix II) and the purpose was to check driver's driving violations and confirm some of the answers given by respondents with respect to their behavioural feedback to improved road condition and vehicle characteristics.

Published and unpublished works in books, journals, newspapers, articles, reports, Internet, magazines as well as conference papers and working papers that treat aspects of the topic under investigation were consulted in order to obtain the relevant secondary information for the study.

The national crash data on the selected highway (from NRSC and MTTU, Cape Coast) was also used prominently in the work in assessing the trend of road traffic crashes in terms of the persons killed and those injured on the highway over the years and in testing the hypotheses.

Target population

The study focussed on vehicles with Airbag, ABS or Electronic Stability Control (ESC). In this regard, the target population of the study consisted of drivers of private vehicles with the above named safety devices. Vehicles manufactured between the periods of 1992 to 2010 were sought after since they had one or more of the safety devices of interest. These vehicles were divided into two- modern and old based on the number of safety devices they had installed in them. All professional vehicles such as vans, taxis and lorries were excluded from the study.

Sample size

The sample size for the study was calculated from a list of private vehicles registered (573 vehicles) at the Central Regional DVLA office during the period 2009. This list comprised of vehicles manufactured within the period 1992- 2010. The 2009 list was used mainly due to the fact that it was the most recent at the time of the study. Twenty (20) percent of this total number (114.6) which approximates to 115 private vehicles was selected for the study. This percentage was selected based on convenience.

Sampling techniques

The non-probability sampling technique in the form of purposive sampling was employed in selecting the relevant sample for the study. This technique enabled the researcher to select the relevant vehicles and their drivers for the study. Also this helped greatly since there was no sampling frame on the actual number of private vehicles that use or have ever used the highway which also have these safety devices of interest (Airbag, ABS or ESC). These drivers were contacted and interviewed at parking lots, washing bays, and places of social gathering.

Research Instrument

In consonance with mixed methods approach which guided the study, observation and questionnaire instrument was employed in collecting the primary data on the topic under investigation. The selection of these instruments was based on the fact that they are the most popular and relevant for the study in question and can produce quick results as well.

The questionnaire was basically semi-structured and comprised many closed ended questions. This facilitated easy administration of the questionnaires. It also helped greatly to avoid irrelevant answers from respondents and made data inputting easy.

The study adopted modified versions of the speed-choice (French, West, Elander, & Wilding, 1993) and driving violation (Parker et al., 1995) questionnaires to sample views on driver speed choice and driver risk taking behaviour respectively. The questionnaires provided a good possibility for gathering data on many aspects of driving behaviour at a low cost (Iversen, 2004).

The questionnaires were sub-divided into four modules or sections using the objectives for the study and to make it easier for the respondents to understand and answer. The modules were:

- Socio-demographic characteristics (gender, age, educational attainment, marital status, occupation, driving experience) which would allow the researcher establish some relationship for a better understanding of road safety issues;
- Road traffic crashes in Ghana especially on the Accra- Cape Coast highway which sought to ascertain respondents knowledge of the road traffic crash situation in the country especially those on the Accra- Cape Coast highway;
- Vehicle safety devices which also sought to determine respondents perceptions about vehicle safety devices and their functions and lastly;
- Effect of vehicle safety devices on driving behaviour and road traffic crashes which invited respondents to share their views on the effect these devices have on driving behaviour and subsequently on road traffic crashes.

Moreover, field observation was done to inform the researcher on drivers risk taking behaviour (tailgating, red light jumping etc) on the highway; the model of vehicles they drive and gender of the drivers.

Pre- testing

Ten of the designed questionnaires were pre-tested on the 24th of October, 2010 at Elmina to allow the researcher ascertain how effective they would be in the field as a data collection instrument as well as their feasibility. The researcher visited two washing bays in the area and administered the questionnaires. The respondents were selected purposively based on the vehicles they drove. This helped in making the necessary modifications in the questionnaire for the main data collection.

Actual fieldwork

The actual fieldwork exercise was carried out on the 20th of November, 2010 at 5pm. The data collection team consisted of three people- the researcher and two research assistants. The exercise lasted exactly one month and two days (20th November 2010 – 22nd December, 2010). On the average, ten (10) questionnaires were administered per day. Saturdays and Sundays were used as the main data collection days because it was easier to locate the vehicles of interest and their respective drivers. The drivers were easily located at washing bays during these days in question.

Response rate

The actual response rate from the study was somewhat good compared with the assumed response rate. In the whole 104 out of 115 questionnaires were completed and returned representing a 90.4 per cent response rate.

Data processing and analysis

Data collected from the field were cross-checked for consistency and accuracy. They were then numbered serially, coded, and fed into the computer. The Statistical Product and Service Solutions (SPSS) software version 13 was used to obtain frequency distributions, cross tabulations and graphical illustrations.

Binary logistic regression and chi square statistic were also employed in testing and analyzing the hypotheses of the study. The variables tested were vehicles safety devices (ESC, Airbag, and ABS), age, gender and driver speed choice (independent variables) and driver speed choice and driver risk taking behaviour (dependent variable)- logistic regression and road traffic casualties and the causes of the crashes (chi square analysis).

Field experiences and related challenges

Observation of drivers' risk taking behaviours on the highway was carried out three times daily (morning 7am; afternoon 1pm and evening 5pm) on the following days: Monday 22th November; Friday 26th November; and Saturday, 18th December. These days were selected in order to determine whether the way people drive was influenced by the day of the week and the time. Generally, the exercise was smooth but for a few challenges which hindered the process in some ways. Firstly, in terms of driver speed choice observation, the researcher was unable to secure the radar/ speed gun from the police to determine exactly the speed drivers drove their vehicles on the highway during the periods of observation.

There was also an issue with participation in the study. Quite a sizeable number of people who had the vehicles of interest would not want to participate in the study for reasons best known to them. Furthermore, there was the problem of uncompleted questionnaires which resulted in the issue of no response options with some of the questions on the questionnaire. In this regard eleven questionnaires were also not returned.

CHAPTER FIVE

RESULTS AND DISCUSSION

Introduction

This chapter presents the findings emanating from the data collected through the self-administrated questionnaires and observations made. The chapter analyses all the thematic areas of the data collection instrument used such as the socio-demographic information of respondents, respondents' knowledge on road traffic crashes in Ghana especially on the Accra-Cape Coast highway and information about vehicle safety devices. The section also examines the effects of vehicle safety devices on driving behaviour and road traffic crashes touching also on respondents' attitudes towards vehicle and road infrastructure improvements. Hypotheses for the study were also tested and discussed in the course of the analysis.

Socio- demographic characteristics of respondents

A total of 104 respondents, mainly private car drivers, were covered by the survey. As indicated in Table 7, a total of 85 representing 81.7 per cent were males and 19 (18.3%) were females. This is a valid representation as far as the male-female driver ratio in Ghana is concerned. Generally there are more male licensed drivers than their female counterparts (see Abane, 2010). With respect to the ages of the respondents, nearly half (44.2%) were in the age range of 30- 39 years at the time of the survey. A substantial proportion of the respondents (89.4%) had attained tertiary education (University/ Polytechnic). This has implications on their attitude and behaviour when driving. For instance, Jorgensen and Abane (1999) argued that a driver's level of education influences his/her attitude and behaviour when driving. They observed that it is normal to expect those with adequate formal education to be able to use road signs and markings to their advantage when behind the wheel.

The majority of the respondents (61.5%) were engaged in the quaternary sector of the economy. The quaternary sector of the economy engages in intellectual activities. Activities associated with this sector include government, libraries, scientific research, education, and information technology. However, 2.9 per cent were involved in the quinary sector, which includes the highest levels of decision making in a society or economy. This sector includes the top executives or officials in such fields as government, science, universities, non-profit, healthcare, and the media.

With respect to their marital status, nearly 65 per cent were married; with 2.9 per cent either divorced or separated. Table 7 also shows the respondents' driving experience. Of the total, 40 per cent had had more than 10 years of driving experience. Only 9 per cent had driven for less than a year at the time of the survey. It emerged that the majority of the respondents (85.6%) drive every single day of the week while only a small fraction of the respondents (1.9%) drive two or fewer times per week.

Table 7: Socio-demographic characteristics of respondents

Variable		Frequency	Percent
Gender	Males	85	81.7
	Females	19	18.3
Age group (year)	< 20	1	1.0
	20-29	30	28.8
	30-39	46	44.2
	40-49	3	2.9
	≥ 50	24	23.1
Highest education	Primary/Middle/JHS	5	4.8
	SHS	1	1.0
	Vocational/Technical/ Commercial/Teacher training	5	4.8
	University/Polytechnic	93	89.4
Occupation (sector of economy)	Secondary	7	6.7
	Tertiary	26	25.0
	Quaternary	64	61.5
	Quinary	3	2.9
	Unemployed	4	3.8
Marital status	Single	34	32.7
	Married	67	64.4
	Divorced	2	1.9
	Separated	1	1.0
Driving experience (years)	< 1	10	9.6
	2-5	33	31.7
	6-9	19	18.3
	≥ 10	42	40.4
Frequency of driving	Everyday	89	85.6
	More than 3 times a week but not everyday	13	12.5
	2 or fewer times per week	2	1.9

Source: Field survey, 2010

Road traffic crashes on the Accra- Cape Coast highway

The study also sought information about the respondents' level of knowledge about the road traffic crash situation in Ghana especially those on the Accra-Cape Coast highway which is of interest as far as this study is concerned. Knowledge of this may serve to deter people from acts or activities which can bring about road crash.

On the average, more than half of the respondents (77.4%) were of the opinion that the rate of road traffic crashes in the country especially that on the Accra-Cape Coast highway is very high. Not only is it very high, they also chose to describe it with phrases like 'increasing', 'alarming', 'precarious' and even 'pathetic'. These phrases connote the seriousness of the situation at hand.

Information about the respondents' level of confidence on the safety of vehicles on the road in Ghana today was also sought. It was realised that 48.5 per cent of those covered in the survey were fairly confident that vehicles on the roads in Ghana are safe to travel in or with. A possible reason for this confidence can be the strict laws and regulation on the importation of over-aged vehicles into the country, coupled with strict vehicle roadworthy examination by the Driver and Vehicle Licensing Authority (DVLA). Thus respondents believe vehicles imported into the country nowadays are modern and less defective as compared to times past. Nearly 5 per cent were however not at all confident in the safety of vehicles on Ghana's roads today as Table 8 reveals.

Table 8: Level of confidence about safety of vehicles on Ghana's road today

Level of confidence	Frequency	Percent
Very confident	9	8.7
Fairly confident	50	48.5
Not very confident	39	37.9
Not at all confident	5	4.9
Total	103	100.0

Source: Field survey, 2010

The relationship between respondents' socio-demographic background (gender and age) and their levels of confidence about the safety of vehicles was also explored (Table 9). The chi square test results revealed that one's level of confidence about the safety of vehicles was influenced by age rather than gender. The relationship between level of confidence about the safety of vehicles and age was significant (χ^2 = 27.347; p = .038) while that between level of confidence about safety of vehicles and gender was not significant using the 0.05 significance level. The study also sought to find out from the respondents what they considered to be the greatest cause of road traffic crashes in Ghana especially on the Accra-Cape Coast highway (Table 10).

Table 9: Respondents' level of confidence about safety of vehicles by gender and age

Individual profile		Level of confidence (proportion)			
		Very confident	Fairly confident	Not very confident	Not at all confident
Gender	Male	66.7	84.0	82.1	80.0
	Female	33.3	16.0	17.9	20.0
Age	< 20	0	2.0	0	0
	20-29	22.2	32.0	28.2	20.0
	30-39	11.1	46.0	53.8	0
	40-49	0	0	5.1	20.0
	50+	66.7	20.0	12.8	60.0
Total		100.0	100.0	100.0	100.0

Source: Field survey, 2010

From Table 10, unnecessary over-speeding was seen as the greatest cause of the crashes reported on the highway in the opinion of the respondents. According to the conceptual framework guiding the study (Jorgensen & Abane, 1999), road traffic crashes can be attributed broadly to three main factors namely environmental factors, technical or vehicle- related factors and human factors.

A critical look at the above named causes reveals something very interesting. Apart from lack of vehicle maintenance (technical/ mechanical factor) and nature of the road (environmental factor), all other factors are human related. It accounts for almost 95 per cent of the causes enumerated by the respondents. This confirms what the literature has reported over the years (Jorgensen & Abane, 1999; Abane, 2004). It could also be revealed that unnecessary over-speeding was reported to be the single greatest cause of crashes in the country. This confirms the finding that in Ghana, nearly 60 per cent of the road crashes can be traced to reckless speeding on the road. The situation is not different the world over. A substantial proportion of the world's estimated one million road traffic crashes per year can be attributed to excessive speeding by drivers and other motorists (Abane, 2004).

Table 10: Opinion on the causes of road traffic crashes on the Accra-Cape Coast highway

Causes	Frequency	Percent
Careless/reckless driving	25	24.0
Unnecessary over-speeding	45	43.3
Drunk driving	6	5.8
Wrongful overtaking	11	10.6
Lack of vehicle maintenance	5	3.8
Nature of road	6	5.8
Illiteracy/driver inexperience	6	5.8
Total	104	100.0

Source: Field survey, 2010

Table 11 presents the results of the relationship between one's educational attainment and his/her opinion of the cause of road traffic crashes in Ghana. Educational attainments were categorized into two for the purposes of this analysis- Pre-University (Primary/Middle school, SHS and Vocational) and University. Those who had attained University education at the time of the study were more likely to enumerate careless/reckless driving (23.7%), over-speeding (46.2%) and overtaking (10.8%) as the main causes of the road traffic crashes in Ghana especially on the Accra-Cape Coast highway than respondents who had pre-university education.

Table 11: Perceived causes of road traffic crashes by educational attainment

	Educational attainment (proportion)	
Causes	Pre-University	University
Careless/reckless driving	27.3	23.7
Unnecessary over-speeding	18.2	46.2
Drunk driving	9.1	5.4
Wrongful overtaking	9.1	10.8
Lack of vehicle maintenance	0	5.4
Nature of road	27.3	3.2
Illiteracy/driver inexperience	9.1	5.4
Total	100.0	100.0

Source: Field survey, 2010

A further analysis of this result revealed a significant relationship (χ^2 = 12.790; p = .047) at 95 per cent degree of confidence between educational attainment and one's opinion of the cause of road traffic crashes in Ghana. From the above it is thus clear that one's educational attainment influences his/her opinion of the cause of road traffic crashes as far as this study is concerned.

The good surface condition of the Accra-Cape Coast highway was confirmed by the respondents covered in the survey. Table 12 indicates that more than three-fourth of them agreed to the fact that the condition of the highway is excellent (26.0%), very good (37.5%) and good (30.8%) even though 5.8 per cent believe the highway needs improvement. According to them there are too many curves and speed bumps on the highway. In their opinion this situation needs to be addressed.

Table 12: Condition of the Accra- Cape Coast highway

Condition of highway	Frequency	Percent
Needs improvement	6	5.7
Good	32	30.8
Very Good	39	37.5
Excellent	27	26.0
Total	104	100.0

Source: Field survey, 2010

The view that most drivers perceive the good surface condition of the Accra-Cape Coast highway as an opportunity to speed excessively (Abane, 2010) was as well confirmed by the fact that 63.5 per cent of the respondents were of the opinion that the present condition of the highway facilitates over-speeding (Figure 3). This is invariably a manifestation of the Peltzman's risk compensation hypothesis. According to the hypothesis whenever road users perceive a reduction in the degree of risk as a result of a countermeasure (good road surface condition), they respond to this reduction in risk by acting riskily (in this case over-speeding) thus negating the safety benefit of the countermeasure. Road condition is one of the key factors which influence road traffic crashes as espoused by the Jorgensen and Abane (1999) model which underlines this study. It is thus not surprising that the towns and villages served by the highway are among the most crash-prone areas in the region (Abane, 2010).

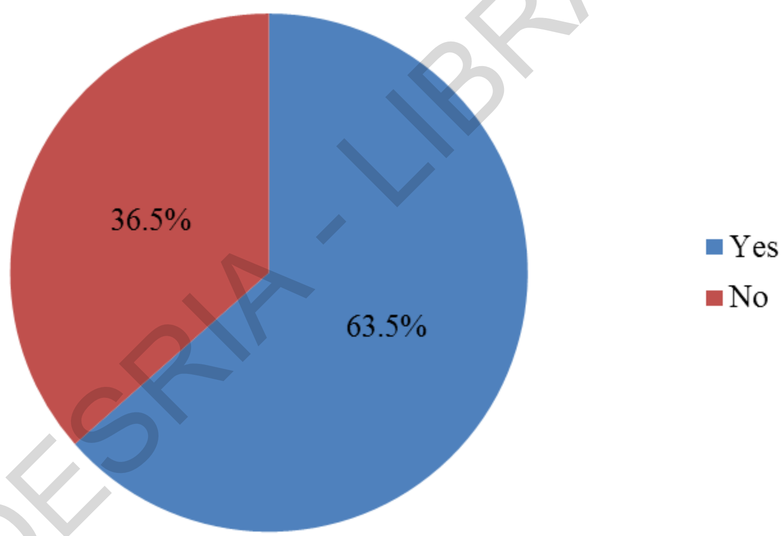


Figure 3: Respondents opinion as to whether the present condition of the Accra-Cape Coast highway facilitate over-speeding

Source: Field survey, 2010

Vehicle type and safety devices

Nearly 53 per cent of the respondents own and drive Toyota (23.1%), Nissan (16.3%) and VW (13.5%) car models. For clarity sake the various car models driven by the respondents were categorized into two subgroups namely 'modern cars' which are usually cars manufactured after the year 2000 and 'older cars' which are pre- 2000 cars (1992- 1999). A unique distinction between these two categories is the number of safety devices installed in them. Generally, modern cars have more sophisticated safety features than older cars (Fosser & Christensen, 1998). On this basis, it was observed that the majority of the respondents (68.3%) drove modern cars as compared to older cars (31.7%).

The choice of a particular car model was based on a number of factors the respondents considered paramount, among which were how fuel efficient the car is, the price of the car, and engine durability. As Table 13 shows, a substantial number of the respondents (60.6%) chose their current cars basically because these cars were safe, stable, durable and give them comfort as well. The data also shows that the least considered factor was that of the engine in terms of whether it was durable or not. This accounted for only 5.8 per cent.

Apart from seatbelt, the vehicles driven by the respondents also had certain safety features installed in them namely airbag, antilock braking system brakes (ABS) and electronic stability control (ESC). These devices perform various functions to ensure that vehicles are safe to drive in.

Table 13: Reasons for current car choice

Reasons	Frequency	Percent
Availability of spare parts and fuel efficiency	20	19.2
Affordable	15	14.4
Excellent car safety, stability, durability and comfort	63	60.6
Car engine is durable	6	5.8
Total	104	100.0

Source: Field survey, 2010

Table 14 indicates that 33.7 per cent of these cars had a combination of airbag, ESC and ABS; 29.8 per cent had both airbag and ABS whilst 22.1 per cent had airbag only. Vehicles with only ABS, ESC and both airbag and ESC were few.

Table 14: Safety devices installed in respondents' vehicles aside seatbelt

Safety features	Frequency	Percent
Airbag, ESC and ABS	35	33.7
Airbag and ABS	31	29.8
Airbag and ESC	4	3.8
Airbag	23	22.1
ESC	2	1.9
ABS	9	8.7
Total	104	100.0

Source: Field survey, 2010

The belief that modern cars have more sophisticated safety devices was ascertained by comparing the devices respondents reported having in their cars. A look at Table 15 reveals that 26 of the modern cars sampled as against 9 older cars had all three safety devices of interest (Airbag, ABS and ESC). It was also realised that airbag is a common feature of older vehicles apart from seatbelt as 20 older vehicles were reported to have airbag only.

Table 15: Safety features by car model

Safety features	Car model		
	Modern car (2000 to date model)	Older car (pre-2000)	Total
Airbag, ESC and ABS	26	9	35
Airbag and ABS	16	15	31
Airbag and ESC	2	2	4
Airbag	3	20	23
ESC	2	0	2
ABS	4	5	9
Total	53	51	104

Source: Field survey, 2010

When asked to indicate other safety devices which were not on their vehicles, the majority of the respondents (62.5%) had problems doing so. Notwithstanding, a few could pinpoint certain safety devices which were not available in their current vehicles. Among these were:

- ABS (8.7%)

- ESC (10.6%)
- Airbag (7.7%)
- GPS system (2.9%)
- Dual braking system and traction control (1.9%)
- Passenger side and Head curtain airbags (1.9%)
- Cruise control (1.9%)
- Seatbelt alert and anti-crash system (1.9%)

It is worth noting that nearly 49 per cent of the respondents covered in the survey had ever experienced the need for the safety devices enumerated (Airbag, ESC and ABS) in the course of their driving. It is also interesting to note that nearly 54 per cent of the respondents were very confident in the safety of their vehicles as against only 1.9 per cent who were not (Figure 4).

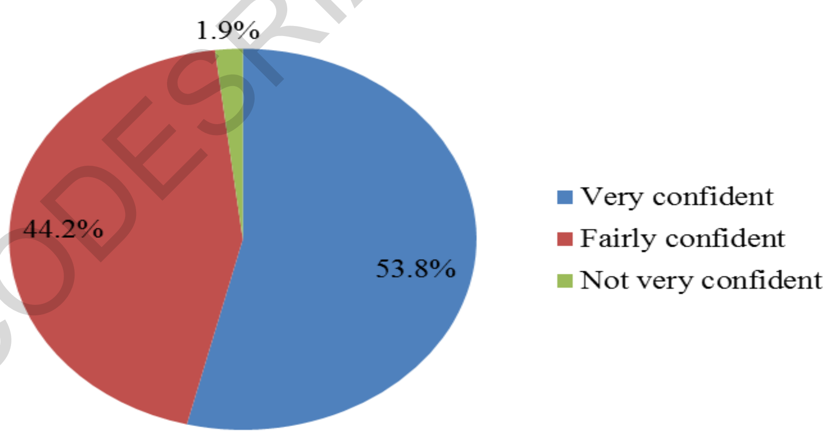


Figure 4: Respondents level of confidence in the safety of their vehicles

Source: Field survey, 2010

The majority of the respondents revealed that they do regular maintenance and that goes to buttress their assertions that their vehicles are safe. Almost 43% of the respondent had this to say. The views of the others are as presented below:

- I trust the track record of the car manufacturers (5.8%)
- The car is well built and safety devices are available (27.9%)
- It has worked for me once (4.8%)
- I don't over-speed nor do I engage in reckless driving (1%)

Furthermore by virtue of the fact that the majority of the respondents said they do regular maintenance and also believe their vehicles were 'safe', it was not surprising that almost all respondents covered in the survey were either very confident (52.9%) or fairly confident (39.4%) that the safety devices in their cars would work in an emergency situation. Only a few (7.7%) were not very confident about this. According to them, a car is a machine and as such anything could happen at any time so one could not be perfectly sure whether these devices would work when expected especially in emergency situations (Table 16).

From Table 17 also, the study sought to ascertain whether there were relationship between the level of confidence in the safety of vehicles and socio-demographic characteristics (gender and age). Although males (89.1%) were more likely to be fairly confident in the safety of their vehicles than females (10.9%) (Table 17), the relationship between gender and confidence in the safety of respondent's vehicles was not significant.

Table 16: Level of confidence in the working of safety devices in emergency situations

Level of confidence	Frequency	Percent
Very confident	55	52.9
Fairly confident	41	39.4
Not very confident	8	7.7
Total	104	100.0

Source: Field survey, 2010

Table 17: Level of confidence in safety of vehicle by gender and age

Individual profile		Level of confidence (proportion)		
		Very confident	Fairly confident	Not very confident
Gender	Male	75.0	89.1	100
	Female	25.0	10.9	0
Age	< 20	1.8	0	0
	20-29	25.0	30.4	100
	30-39	37.5	54.3	0
	40-49	0	6.5	0
	50+	35.7	8.7	0
Total		100.0	100.0	100.0

Source: Field survey, 2010

But on the other hand, a significant relationship existed at 95 per cent confidence level (χ^2 = 19.460; p = .013) between age and respondent's confidence in the safety of their vehicle.

To really tell whether the safety devices are working or in control depend on the car model and its manufacturers. But ideally there are certain indicators or changes to show. In the survey, although 15.4 per cent had never experienced the working of these safety devices before, the majority of the respondents reported that they got to know whether the safety devices in their vehicles were working or not when signs appear on their dashboards which go off with time upon car start-ups (70.2%).

The study went further to ascertain respondents' opinions on the benefits of having safety features installed in their vehicles. About 67 per cent responded that these devices offered safety and driver security (Table 18).

Table 18: Benefits of safety features

Benefits of safety features	Frequency	Percent
Safety and driver security	70	67.3
Accident reduction and prevention	21	20.2
Better driver control and stability	11	10.6
Reduced likelihood of going off the road or into the ditch	2	1.9
Total	104	100.0

Source: Field survey, 2010

A couple of them (20.2%) also believed the devices helped by way of crash reduction and prevention.

A further analysis of the data showed an interesting issue that both males (68.2%) and females (63.2%) were more likely to believe that safety features brought safety and driver security. The same argument could be raised for all the other benefits these features were reported to be providing (Table 19).

Table 19: Benefits of safety features by gender

Benefit	Gender of respondents	
	Male	Female
Safety and driver security	68.2	63.2
Accident reduction and prevention	22.4	10.5
Better driver control and stability	7.0	26.3
Reduced likelihood of going off the road or into the ditch	2.4	0
Total	100.0	100.0

Source: Field survey, 2010

As Table 20 indicates, nearly 46 per cent revealed that even though these safety devices are beneficial as reiterated above, the driver may become overly confident and increase risk taking. Others (37.4%) were also of the opinion that the driver may become dependent or reliant on the technology; yet a section (9.1%) believes these features would have no effect on drivers.

Table 20: Effects of safety features on drivers

Effects of safety features	Frequency	Percent
Loss of control by the driver	8	8.0
Driver may become dependent or reliant on the technology	37	37.4
Driver may become overly confident and increase risk taking	45	45.5
No effect	9	9.1
Total	99	100.0

Source: Field survey, 2010

Again the fact that safety is high on the agenda of most drivers covered in the survey is reiterated. When asked to pinpoint the most important features out of the range of features or options which they would consider should they decide to buy a vehicle then, a seeming majority (68.3%) indicated that they would consider safety features available on a particular car before purchasing it. The issue of car make and model was also high on the agenda of most respondents whilst car speed and power was the least (1%) considered (Table 21).

Table 21: Features respondents considered during the purchase of new cars

Feature	Frequency	Percent
Safety features that are available	71	68.3
Vehicle size	3	2.9
Comfort and convenience	7	6.7
Car make and model	16	15.4
Car speed and power	1	1.0
Added extra	6	5.7
Total	104	100.0

Source: Field survey, 2010

A further analysis of the features respondents would prefer by gender showed that both male (65.9%) and female (78.9%) drivers covered in the study would value safety features and car make and model highly should they wish to purchase a new vehicle (Table 22).

The study also sought to explore whether there was a relationship between the variables features respondents preferred and gender. The chi square output showed no significant relationship between the features respondents preferred and gender.

Table 22: Features respondents considered during the purchase of new cars by gender

Features respondents prefer	Gender of respondents	
	Male (%)	Female (%)
Safety features that are available	65.9	78.9
Vehicle size	2.4	5.3
Comfort and convenience	8.2	0
Car make and model	15.3	15.8
Car speed and power	1.2	0
Added extra	7.0	0
Total	100.0	100.0

Source: Field survey, 2010

Effect of vehicle safety devices on driving behaviour and road traffic crashes

Speed choice has been consistently shown to relate to drivers' crash involvement in the literature (Horswill & Coster, 2002) and has been shown to be one of the best predictors of crash involvement compared with other behaviours. It is upon this basis that the study sought to determine the speeds respondents considered comfortable especially during a journey on the Accra-Cape Coast highway. By law (Ghana Highway Code, 1974), drivers are required to travel at the speed of 80 km/h (speed limit) on the highway. Table 23 reveals that the majority (67.4%) of the respondents do travel between 80 and 100 km/h on the highway. Notwithstanding, a substantial number (20.2%) also felt comfortable driving at the speed of 120 km/h on the highway. It was observed during the roadside observation that generally drivers sought every opportunity to speed up during their journey on the highway especially when the road was ‘clear’.

Table 23: Speed respondents feel comfortable driving when on the highway

Speed choice	Frequency	Percent
60 km/h	13	12.5
80 km/h	35	33.7
100 km/h	35	33.7
120 km/h	21	20.2
Total	104	100.0

Source: Field survey, 2010

Respondents covered in the study chose their respective speeds basically because those speeds allow for better vehicle control and safety (55.8%). Other reasons highlighted at the time of the survey were as follows:

- It is the legal speed limit on the highway (13.5%)
- It is fuel efficient and helps me to arrive at destination quick (15.4%)
- To avoid crash and also being a nuisance to other road users (15.4%)

The fact that the majority of those covered in the study sought every opportunity to speed is confirmed by their responses to the question of whether or not traffic conditions make them drive slower than preferred. Nearly 78 per cent responded in the affirmative with the remaining 22 per cent responding negatively.

Also, the issue of whether or not the presence of safety features in cars influence people’s driving behaviour was addressed (Figure 5). About 70 per cent believed that the presence of these features does influence driving behaviour although the remaining 29.8 per cent of the respondents had contrary views to this. This finding is in conformity with earlier finding reported above that the presence of safety features in cars make drivers overly confident and increased their risk taking behaviour.

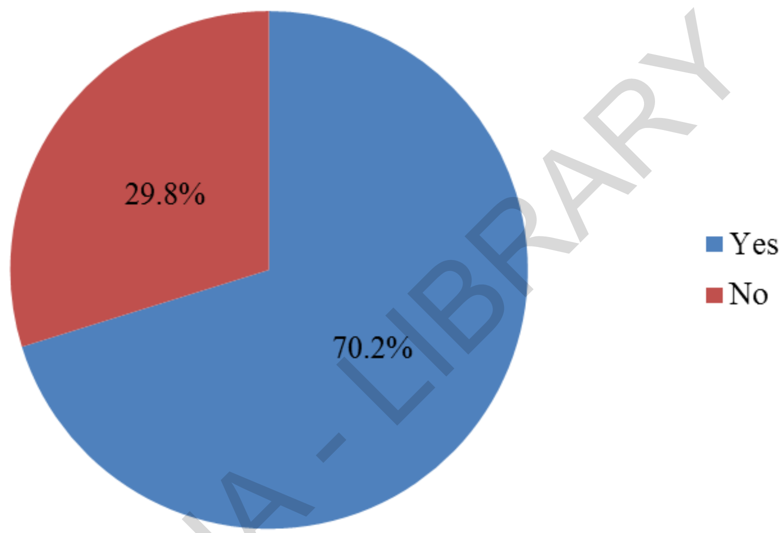


Figure 5: Respondents opinion as to whether or not vehicle safety features influence driver's driving behaviour

Source: Field survey, 2010

With respect to those who responded yes to the above question, more males (92.6%) than females (7.4%) believe the presence of vehicle safety features offer drivers a false sense of security and safety; encourage drivers to drive less carefully (84% vs. 16%) as well as drive faster and aggressively (85% vs. 15%) as Table 24 indicates.

Table 24: Impacts of vehicle safety features on driving behaviour by gender

	Gender of respondent (%)		
Impact	Male	Female	Total
Encourage drivers to drive less carefully	84	16	100.0
Encourage drivers to drive faster and aggressively	85	15	100.0
Allows a false sense of security and safety	92.6	7.4	100.0

Source: Field survey, 2010

Vehicle safety devices and driver speed choice

The study sought to determine the relationship between availability of vehicle safety devices and driver speed choice. In this regard the logistic regression technique was employed. Logistic regression was preferred to other multivariate techniques because of its robustness and sensitivity to outliers (Nwakeze, 2007). In addition, it has the advantage of estimating odds ratios for each variable to determine how much each is likely to explain the dependent variable. It also has the ability to accept independent variables of varying measurement levels (Sweet, 1999). For a logistic regression, the predicted dependent variable is a function of the probability that a particular subject will be in one of the categories, in this case whether the respondents will choose a high speed when driving or a low speed given his/ her set of scores on the predictor variables- age, gender, driving experience, opinion of the condition of the highway, car model he/she drives- whether modern or old, perceived safety of one's vehicle, available safety devices and the confidence that these safety devices would work in an emergency situation. The driver speed choice was re-coded into a binary function with 0 representing low speed choice and 1 high speed choice. Thus each case was expected to fall into one or the other of the dichotomous categories.

The output of the analysis is shown in Table 25. The B values provided are the values that indicate the probability of a case falling into a specific category. A positive or negative value indicates the direction of the relationship (whether the factors increase the likelihood of the event occurring or decrease it). The Exp (B) represents the odds ratio, and the significance (Sig.) shows the degree of importance the individual predictor has on the entire model. To be considered significant to the model, a predictor variable should have a combined odds ratio value of more than 1 and a significance value less than 0.05 (Sweet, 1999; Kinnear & Gray, 2002). When Exp (B) is less than 1, increasing values of the variable correspond to decreasing odds of the event's occurrence and vice-versa.

It needs be mentioned that, on the whole, the model fit fairly well, accounting for approximately 88 per cent of the explained variation. In assessing the fit of the model, the Hosmer-Lemeshow Test was used. For the Hosmer-Lemeshow Goodness of Fit Test, poor fit is indicated by a significance value less than .05. So to support a model, a value greater than .05 is needed (Pallant, 2005). The chi square value for the Hosmer-Lemeshow Test is 8.680 with a significance level of .370. This value is larger than .05, therefore indicating support for the model. Employing a 5 per cent criterion of statistical significance, the predictor variable driving experience was statistically significant having a p- value of less than .05 (p=. 029). The contribution of gender, age, respondent's opinion of the highway condition, car model, perceived safety of respondent's car, available safety devices and confidence that the safety devices would work in emergency situation to the model were insignificant, having p- values higher than .05.

As Table 25 shows, driving experience recorded odds ratio of 2.14, which means that an increase in one's driving experience would result in a high speed choice by an odds of 2.14 times. Thus drivers with more than 10 years of driving experience are 2.14 times more likely to drive at a high speed (100- 120 km/h) than those with lesser driving experience. This confirms the finding from Aberg and Rimmo (1998) and Blockley and Hartley (1995) that the more drivers drive, the more often they tend to violate traffic rules (Bener et al., 2008).

Gender reported an odds ratio of 0.899. Thus with respect to high speed choice, the odds of males taking higher speed are 0.899 times less likely than females. Perhaps, a possible reason accounting for this finding could be the fact that the female respondents covered in the study were fewer than the males. Schoor, Van Nniekirk, and Grobbelaar (2001), for instance argued that females are better drivers than males as they tend to be law abiding and very careful when driving.

Table 25: Output of Binary Logistic Regression of predictor variables for driver speed choice

Variable	B	S.E	Wald	Sig.	Exp (B)
Gender	-.106	.832	0.016	.899	0.899
Age	-.961	.882	1.186	.276	0.383
Driving experience	.762	.350	4.746	.029	2.142
Opinion of highway condition	-.372	.373	0.997	.318	0.689
Car model	.398	.701	0.322	.570	1.489
Confidence in safety of vehicle	.880	.712	1.525	.217	2.410
Available safety devices	-.309	.449	0.473	.492	0.734
Safety devices functional in emergency situations	-.078	.512	0.023	.879	0.925
Constant	.608	1.937	0.098	.754	1.836

Source: Field survey, 2010

Another striking revelation was with age and speed choice. The results revealed that the odds of drivers aged 20–39 years speeding was 0.383 than those aged 40 years and older. Thus drivers aged 20-39 years were less likely than those aged 40 years and older to speed. A study on speed measurements taken in four European countries by Smeed (1973) found that both driver age and driver gender were good predictors of selected speeds, with the young driving faster than the old, and males driving faster than females. Herberg (1978) also found that fast drivers are younger, and tend to have slightly higher crash rates, but found no significant gender differences (Quimby, Maycook, Palmer, & Buttress, 1999).

Speed choice is also influenced by other factors like the particular vehicle one drives (car model), how safe the vehicle is perceived to be by its driver or occupants and more importantly the safety devices available in the vehicle. With respect to the particular vehicle one drives, it was observed that the odds of modern cars being driven faster or at higher speed are 1.49 times more than older cars. Thus modern cars are driven faster than older cars. This is in line with what was observed during the roadside observation. From the table it also became clear that the more a vehicle is perceived to be safer to drive, the more likely it is driven at faster or higher speed. The odds of perceived safer vehicles being driven at higher speed is 2.41 times more likely than those not perceived as safe. This confirms most research findings that modern cars are more likely to be driven faster because modern cars are generally perceived to be safe and have the advantage of more sophisticated safety devices (see for example, Fosser & Christensen, 1998; Horswill & Coster, 2002).

Furthermore, the study results revealed that the more safety devices the respondents had in their vehicles, the less likely they were to speed or drive faster. It thus emerged that availability of more than one safety device in a vehicle would result in a less than proportional speed choice. That is, the odds of a vehicle having more than one safety device (2- 3 safety devices) being driven faster is only 0.734. This is contrary to the belief that vehicles with more safety devices are driven faster than normal.

Again, another feature from the table which is worth noting is the B values (coefficients). It is seen that variables such as driving experience, car model and confidence in the safety of vehicles reported positive B values. This shows a direct relationship with the odds ratio and the likelihood of the dependent variable (driver speed choice) recording a score of 1 (high speed choice). The rest of the independent variables indicated an inverse relationship with the odds ratio and the likelihood of the dependent variable recording a score of 1.

Risk taking behaviour of drivers by gender, age and available vehicle safety devices

Another objective of the study was to evaluate the relationship between drivers' risk taking behaviour and gender, age and availability of safety devices in vehicles. The risk-taking behaviours to be measured are drivers' choice of speed and driving violations. Driver risk taking behaviour is here operationalized as the speed at which a driver drives a car (speed choice) and other behaviours and attitudes exhibited on the road which are against the road traffic regulations, for example tailgating and drunk driving. The driver risk taking behaviour was also re-coded into a binary function with 0 representing low risk taker and 1 high risk taker. Each case was expected to fall into one or the other of the dichotomous categories.

The result of the logistic regression analysis of driver risk taking behaviour as the dependent variable and the predictor variables are presented in Table 26. Although none of the predictor variables were significant they were able to predict correctly 69 per cent of the variations in the dependent variable driver risk taking behaviour. Again the Hosmer-Lemeshow Test was used to assess the fit of the model. In a whole the model did also fit well having obtained a chi square value of 6.924 and a significance level of .545 (which is larger than .05). Moreover, the odds ratios it presents provide useful insights into risk taking behaviour in general with respect to the predictor variables under review.

Table 26: Output of Binary Logistic Regression of predictor variables for driver risk taking behaviour

Variable	B	S.E	Wald	Sig.	Exp (B)
Gender	.002	.613	0.000	.997	1.002
Age	-.786	.532	2.186	.138	0.456
Level of education	.292	.383	0.584	.445	1.340
Driving experience	.046	.238	0.038	.846	1.047
Car model	-.273	.502	0.297	.586	0.761
Confidence in safety of vehicle	-.541	.455	1.410	.235	0.582
Available safety devices	.469	.329	2.034	.154	1.599
Driver speed choice	-.083	.671	0.015	.901	0.920
Constant	-.831	1.958	.180	.671	0.436

Source: Field survey, 2010

The assertion that males are risk takers when driving is very much founded with the output above. It was observed that the odds of males taking high risk than females when driving is 1.00. This means that males are more likely to take high risk when driving than their female counterparts.

An intriguing aspect of the output is the issue of age and risk taking when driving. From the table, it is realised that drivers aged 20-39 years are less likely than those aged 40 years and older to take high risk when driving. Drivers aged 20-39 years are 0.456 times less likely than those aged 40 years and older to take high risk when driving. A possible explanation here could be with the issue of driving experience which comes with age and which tends to make one more complacent especially when driving. The more complacent one is the more one would want to take risk. There has been a reasonably large body of research suggesting that novice drivers do not engage in as much risk behaviour as slightly older drivers (Harrẽ, Brandt, & Dawe, 2000).

Availability of safety devices in a vehicle is also reported to influence driver risk taking behaviour (Peterson, Hoffer, & Millner, 1995; Sagberg et al., 1997). The study outcome seems to support this assertion. Vehicles with more than one safety device are more likely to be driven riskily than those with fewer safety devices. For instance, it could be realised that the odds that vehicles with more than one safety device being driven aggressively or being involved in high risk taking is 1.59 times more than those with only one safety device. Lave and Weber (1970) revealed that drivers will drive faster if their vehicles have more safety devices. A driver will take greater risk to compensate for the additional safety in order to arrive at his/her destination sooner.

Gender, level of education, driving experience and availability of safety devices had a positive relationship with the odds ratio which means that an increase in any of these variables would result in a more than proportionate increase in driver risk taking behaviour while a change in age, car model, confidence in the safety of vehicle and driver speed choice would result in a less than proportionate change in driver risk taking behaviour (inverse relationship).

Attitude towards vehicle and road improvements

The study also sought to determine the attitudes of respondents towards vehicle and road infrastructure improvements. With regards to the respondents' attitudes towards vehicle and road improvements, it could be seen from Table 27 that the majority of the respondents agreed to all statements measuring their attitudes and subsequent responses to vehicle and road infrastructure improvements. For instance, the study revealed that about 57.7 per cent of the sampled drivers rely on the safety features in their vehicles too much and do not pay enough attention to their driving. This supports a study by Rudin- Brown et al. (2008) in Canada where it was established that many people (86%) believe that Canadian drivers rely too heavily on vehicle safety features. More specifically, people believe that safety improvements in cars make it possible to drive at greater speed.

Nearly 84 per cent also agreed to the statement that with recent vehicle safety improvements, drivers do not have to worry much when driving on slippery road surfaces. This is contrary to what Rudin- Brown et al. (2008) reported. They revealed that 72 per cent of Canadians do not believe that recent safety devices have an impact on driving in slippery road surfaces.

Table 27: Attitudes towards vehicle and road improvements

Attitude	Percent (%) Disagree	Agree	Total
Drivers rely too much on safety features in their vehicles	42.3	57.7	100.0
It is important to have up-to-date safety features	40.4	59.6	100.0
Vehicle safety improvements foster greater speed	42.3	57.7	100.0
With vehicle safety improvements, drivers have no worry when on slippery roads	16.3	83.7	100.0
More safety devices influences the desire to take risk	41.3	58.7	100.0
Road improvements makes driving less taxing and thus reduces drivers concentration	42.3	57.7	100.0
Lane and road width increase leads to increase in driver's speed	44.2	55.8	100.0
More road lanes lead to more crashes	23.1	76.9	100.0

Source: Field survey, 2010

Respondents' knowledge on the impact of road infrastructure improvement on driving behaviour and subsequently on road traffic crash involvement was also tested. As indicated on the Table 27, majority did agree to the fact that road improvements make driving less taxing and as a result drivers may not be attentive as they drive (57.7%); lane and road width increase would result in increase in driver speed choice (55.8%) and this has the tendency to increase crashes (76.9%).

A number of researchers have noted that demographics play a role on the perceived impact of safety features on driving behaviour (Rudin- Brown et al., 2008). From Table 28, it could be realised that more males (80%) than females (20%) agreed to the statement that some drivers rely too much on the safety features in their vehicles. On the other hand, more males than females disagreed with this statement (84.1% vs. 15.9%).

The results further show that more males than females agreed to the statement that it is important to have most up-to-date safety features in a car (80.6% vs. 19.4%). This confirms the finding that more males than females would place priority on the availability of safety devices in their would-be car if they were to buy a new car. Men were also more likely than women to believe that safety improvements allow for driving at higher speeds (80.5% vs. 19.5%).

Table 28: Attitudes towards vehicle and road infrastructure improvements by gender

Attitude	Gender			
	Male		Female	
	Agree (%)	Disagree (%)	Agree (%)	Disagree (%)
Drivers rely too much on safety features in their vehicles	80.1	84.1	20.0	15.9
It is important to have up-to-date safety features	80.6	83.3	19.4	16.7
Vehicle safety improvements foster greater speed	80.0	84.1	20.0	15.9
With vehicle safety improvements, drivers have no worry when on slippery roads	80.5	88.2	19.5	11.8
More safety devices influences the desire to take risk	78.7	86.0	21.3	14.0
Road improvements makes driving less taxing and thus reduces drivers concentration	83.3	79.5	16.7	20.5
Lane and road width increase leads to increase in driver's speed	81.0	82.6	19.0	17.4
More road lanes lead to more crashes	82.5	79.2	17.5	20.8

Source: Field survey, 2010

Table 29 presents respondents' attitudes towards vehicle and road improvements by age (20-39 and 40 and older categories). Drivers aged 20-39 years were more likely than older drivers to agree with the statements on attitudes towards vehicle and road infrastructure improvements. For example, drivers aged 20-39 years were more likely than drivers those 40 years and older to believe that vehicle safety improvements make it possible to drive at greater speed (81.7% vs. 18.3%). However, 20-39 aged drivers disagreed with the suggestion that more lanes leads to more crashes (79.2% vs. 20.8%).

Table 29: Attitudes towards vehicle and road infrastructure improvements by age

Attitude	Age			
	Young (20-39 years)		Old (40+ years)	
	Agree (%)	Disagree (%)	Agree (%)	Disagree (%)
Drivers rely too much on the safety features in their vehicles	75.0	77.3	25.0	22.7
It is important to have up-to-date safety features	75.8	76.2	24.2	23.8
Vehicle safety improvements foster greater speed	81.7	68.2	18.3	31.8
With vehicle safety improvements, drivers have no worry when driving on slippery roads	75.9	76.5	24.1	23.5
More safety devices influences the desire to take risk	83.6	65.1	16.4	34.9
Road improvements makes driving less taxing and thus reduces drivers concentration	80.0	70.5	20.0	29.5
Lane and road width increase leads to increase in driver's speed	75.9	76.1	24.1	23.9
More road lanes lead to more crashes	75.0	79.2	25.0	20.8

Source: Field survey, 2010

Road infrastructure improvement and traffic casualties

Using crash data from the Motor Traffic and Transport Unit (MTTU) on the Accra- Cape Coast highway from the period 2003-2010, the study sought to determine the relationship between road infrastructure improvement and traffic crash casualties. In this regard the study sought to ascertain the core cause(s) of the increasing crash cases on the highway since its upgrade in 2003/2004. The cause(s) of the crash invariably has implication on the casualty levels in the event of crash.

The study sampled two crash cases per month on the highway for the period 2003-2010 taking into account the number of casualties (fatal, serious and minor) and the established cause(s) of these crashes per the various crash cases recorded. With respect to the crash casualties by severity, the following definitions were adopted:

- Fatal: if at least one casualty dies of injuries sustained within 30 days of occurrence
- Serious: if at least one person is detained in hospital as an in-patient for more than 24 hours
- Minor: where the most severe injury sustained by a casualty is only minor, requiring at most first-aid attention

An analysis of the established causes of the crash cases by the police revealed excessive speed, driver carelessness/recklessness and mechanical defects as the recurring causes. Thus, the working hypothesis was that excessive speed and driver carelessness/recklessness which constitute driver risk taking were not significantly related to the causes of the various casualties recorded. A chi square test of independence was used to determine the relationship between the crash casualties and causes of the crashes. The chi-square test of independence showed a fair amount of significant patterns of distribution of crash casualties across the causes of the crashes (Table 30). From the Table, it is clear that excessive speed could be blamed for more of the minor (54.6%) and fatal (44.4%) crash cases. Also driver carelessness/recklessness accounted for more minor (38.6%) and serious (37.5%) crash cases.

Table 30: Proportion of crash casualties by causes of the crash

	Casualties		
Cause of crash	Fatal	Serious	Minor
Excessive speed	44.4	31.2	54.6
Careless/recklessness	33.3	37.5	38.6
Mechanical defects	22.3	31.3	6.8
Total	100.0	100.0	100.0

Source: Field survey, 2010

The result showed that at 95 per cent confidence interval, a significant relationship (χ^2= 14.318; ρ = .026) existed between crash casualties and the causes of the crashes. This means that driver risk taking in terms of excessive speed and carelessness/recklessness can be blamed for the increasing road traffic crashes on the highway and invariably the various casualties associated with these crashes. Notwithstanding, other factors could have played a role here.

The fact that driver speed choice and carelessness/ recklessness were found to be significantly related to the crash casualties goes to confirm the risk compensation hypothesis which states that vehicle and road improvements which were designed to ensure safety invariably serve as incentives to drivers to speed and thereby expose themselves to the risk of crash. Not surprisingly, Abane (2010) argued that road traffic crashes are still increasing on the highway mainly because of the unacceptable behaviour of most drivers who perceive the good surface condition of the trunk road as an opportunity to speed excessively, exposing themselves and their passengers to the risk of crashes. Thus road "safety improvements" actually lead to statistically significant increases in total road traffic casualties as suggested by other researches using aggregate safety data (see for example, Noland, 2002; Fridstrom & Ingebrigsten, 1991). Fridstrom and Ingebrigsten (1991) in a similar study in Norway found that extensions and improvements to the nation's road network did not have the expected effect of improving safety.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter presents the summary, conclusions and some recommendations emerging from the findings.

Summary

The study set out to test the risk compensation hypothesis in Ghana using the Accra - Cape Coast highway as a case study. Specifically the study was to:

- ascertain the effect of road infrastructure improvement on road traffic casualties;
- analyze the relationship between age, gender and risk taking behaviour;
- evaluate the relationship between availability of vehicle safety devices and driver speed choice;
- evaluate the relationship between availability of vehicle safety devices and driver risk taking behaviour (speed choice and driving violations).

The study was guided by Jorgensen and Abane (1999) Model for Road Traffic Accidents and the Peltzman's Risk Compensation Hypothesis (1975). The study employed questionnaire and observation for the data collection. Data on road traffic fatalities from the period 2003- 2010 were also obtained from the Cape Coast Regional office of the Motor Traffic and Transport Unit. On the whole, the data collection period lasted exactly one month and two days (20th November 2010 – 22nd December, 2010).

On the whole, 104 respondents were covered in the study. The purposive sampling technique was used to select the relevant sample for the study. Data collected was analysed and presented using frequencies, percentages and cross tabulations. Binary logistic regression and chi square statistic were used to analyse driver speed choice and driver risk taking behaviour and effect of road improvement on road traffic casualties respectively.

The main findings of the study were as follows: The study results revealed that the more safety devices the respondents had in their vehicles, the less likely they were to speed or drive faster. That is the odds of a vehicle having more than one safety device being driven faster is 0.734 less likely as compared to those with only one safety device. There is thus an inverse relationship between vehicle safety devices and driver speed choice. This can also be inferred from the B value of -0.309 which the safety devices as a variable recorded.

No significant relationship was established for the variables age, gender, the car model one drives, one's confidence in the safety of his car and also one's confidence that the safety devices in his car would work in emergency situations. However, driving experience ($p = 0.029$) was found to be significant at 0.05 level of significance. Together, these factors explained 88% of variation in driver speed choice.

The study outcome supported the finding that vehicle safety devices influence driver risk taking behaviour as revealed in the literature and as espoused by the Peltzman risk compensation hypothesis. It was realised that vehicles with more than one safety device were more likely to be driven riskily and aggressively than those with lesser safety devices. The study reported that the odds of vehicles having two or more of the safety devices (Airbag, ESC and ABS) being involved in high risk taking is 1.59 times more likely than otherwise. The contribution of this variable to driver risk taking behaviour was however not significant.

With respect to gender and risk taking behaviour, the study revealed a direct relationship between the two. Thus the general conception or myth that males take a lot of risk than females on the road was supported. The study reported that the odds of males taking high risk on the road were 1.00 times more likely than females. Furthermore, there was an inverse relationship between age and risk taking. Drivers aged 20-39 years were 0.456 times less likely than drivers aged 40 years and older to take risk when driving. This finding though contradicts what is normally known but confirms finding reported by Harrẽ, Brandt and Dawe (2000).

Driver speed choice and carelessness/recklessness were found to be the main causes of the rampant road traffic crashes on the Accra- Cape Coast highway although other factors might have played significant roles here. The chi square analysis of crash data on the Accra- Cape Coast highway (2003- 2010) from the MTTU showed a significant relationship between road infrastructure improvement and traffic crash casualties. This is in conformity with findings from Abane (2010) and the risk compensation hypothesis.

Conclusions

On the basis of the objectives of the study and the subsequent findings presented above, the following conclusions can be drawn:

- The speed at which a person drives a vehicle is a function of many factors. Paramount among these factors is the experience one has acquired in driving. This was reported to contribute significantly to the choice of speed in the process of driving. The study findings indicate that there are yet many factors which the literature did not cover.
- The study indicates that drivers show behavioural adaptation to the safety devices in their cars. Vehicle safety devices tend to influence the propensity for a driver to take risk. More important is the number of devices one has installed in his vehicle. The study outcome seem to support the finding that the more safety devices a person has in his car the more the person would want to take risk while driving.
- Males are more likely than females to take risk when driving. This assertion was strongly supported by the study results. However, the relationship between age and risk taking was not direct. Drivers aged 20-39 years were found to be less likely than drivers aged 40 years and older to take risk on the road. In this respect the issue of experience on the road counts very much.
- The policy of reducing road traffic fatalities by upgrading the highway was defeated as drivers see this as an incentive to speed and involve in much risk taking on the highway. Excessive speed and driver carelessness/recklessness were found to be the most recurring causes of crashes on the highway. It is not surprising the number of persons injured and those killed over the period between the upgrade of the highway

(2003/2004) has increased steadily over the period. However, other factors may also have accounted for this increase.

Implication of the study

The results indicate that increasing the number of safety features and vehicle performance leads to an overall increase in crash liability. The results indicate the importance of considering the impact of the human behaviour feedback component when such vehicle characteristics are designed (Horswill & Coster, 2002).

Recommendations

In line with the main findings of this study, the following recommendations are made. These would work to eradicate or reduce the consequences that would stem from drivers taking unnecessary risks.

- The government and the MTTU should work hard to enforce the speed control measures especially on the highway to reduce the excessive speeds drivers travel on the journey due to the perceived good surface condition of the highway. The MTTU should thus be equipped with speed guns to help them deter speeds at which vehicles travel on the highway.
- Based on the study outcome especially the propensity of drivers of private cars to engage in recklessness based on the fact that they can boast of sophisticated safety devices, it's about time the MTTU and NRSC focus on the activities of private cars on our roads as their contribution to road

traffic crashes is significant. A look at available statistics seems to confirm this.

- The national road safety commission should also consider the issue of altering drivers' perception of vehicle safety features via education. It could be indicated to drivers that sophisticated vehicle safety features do not automatically lead to driver invulnerability as sometimes implied in advertising. They could be told that being aware of a car's safety features may lead to driving behaviours that eliminate the benefit of those features (see Horswill & Coster, 2002).

Contribution to knowledge

The study's contributions to knowledge include:

- The expansion of the knowledge base on the risk compensation hypothesis. Even though a lot of studies have been conducted testing the risk compensation hypothesis such as those by Horswill and Coster (2002) and McCarthy and Talley (1999), the settings have all been in the developed countries. Studies of this nature in Africa and for that matter Ghana is woefully lacking for there has been no single empirical work on the Peltzman risk compensation hypothesis in our part of the world even though Abane (2010) believes that the behaviour of drivers in the country partly supports this phenomenon. This study therefore serves as a major contribution to the knowledge base on this phenomenon in Ghana and probably in Africa as a whole.

- The study also serves as another support for the operation of the Peltzman risk compensation hypothesis. The effect of vehicle safety devices on driver risk taking behaviour as espoused by the risk compensation hypothesis was also supported by the study which adds to the number of studies establishing the relationship between these two issues.

Recommendation for further research

Future research testing the hypothesis can be replicated in other areas in order to draw comparative analysis and generalization for the country as a whole. For instance, the study could be replicated on the Tema motorway which is also one of the crash prone roads in the country.

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APPENDICES

APPENDIX I

UNIVERSITY OF CAPE COAST

DEPARTMENT OF GEOGRAPHY AND REGIONAL PLANNING

DETERMINANTS OF ROAD TRAFFIC CRASHES ON THE ACCRA-CAPE COAST HIGHWAY IN GHANA

QUESTIONNAIRE FOR DRIVERS

INTRODUCTION

This questionnaire is designed to solicit information from you and other selected drivers. Please note that there are no correct or incorrect answers in the survey. The aim of this survey is to investigate your opinions as well as attitude regarding road traffic safety measures. It is therefore important that you respond to all questions. However, if you feel strongly that you cannot answer any question, please pass it and proceed to others.

It will take you roughly 40 minutes to complete this questionnaire. The questions contained in this questionnaire are on both sides of the sheets.

SECTION A: SOCIO-DEMOGRAPHIC INFORMATION

This section has to do with you. The information you give here will allow the researcher to establish some relationship for a better understanding of the road safety issues you will be sharing.

Q1. Indicate your Gender

1. Male ( ) 2. Female ( )

Q2. Your age at the last birth day

1. < 20 years ( )
2. 20-29 years ( )
3. 30-39 years ( )
4. 40-49 years ( )
5. ≥ 50 years ( )

Q3. Highest level of education

1. Primary/Middle/JHS ( )
2. Senior High School ( )
3. Vocational/Technical/Commercial/Teacher Training ( )
4. University/Polytechnic ( ) 5. No formal education ( )

Q4. State your present Occupation

………………………………………………………………………..

Q5. Marital status

1. Single ( )
2. Married ( )
3. Divorced ( )
4. Separated ( )

Q6. Driving experience

1. < 1 year ( )
2. 2-5 years ( )
3. 6-9 years ( )
4. ≥ 10 years ( )

Q7. How often do you personally drive your current vehicle?

1. Every day ( )
2. More than 3 times a week but not every day ( )
3. 2 or fewer times per week ( )
4. Once a week ( )

SECTION B: ROAD TRAFFIC CRASHES ON THE ACCRA- CAPE COAST HIGHWAY

This component of the questionnaire addresses issues about your knowledge of the road traffic crash situation in Ghana especially those on the Accra- Cape Coast highway.

Q8. What is your opinion about the rate of road traffic crash situation in Ghana today?

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…………………………………………………………………………………

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Q9. How confident are you in the safety of vehicles on the road in Ghana today?

1. Very confident ( )

2. Fairly confident ( )

3. Not very confident ( )

4. Not at all confident ( )

Q10. In your opinion what do you consider as the greatest cause of road traffic crashes in Ghana especially on the Accra- Cape Coast highway? …………………………………………………………………………………

…………………………………………………………………………………………

Q11. What is your opinion about the present condition of the Accra- Cape Coast highway?

1. Excellent ( )

2. Very Good ( )

3. Good ( )

4. Needs improvement ( )

Q12. Does the present condition of the Accra- Cape Coast highway facilitate over- speeding?

1. Yes ( ) 2. No ( )

SECTION C: VEHICLE SAFETY DEVICES

In this section, you will be talking about your car, its safety devices, your perceptions about these devices and their functions. Please, study the questions carefully before responding to them.

Q13. Which car model (make and year) do you drive?

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…………………………………………...

Q14. Why did you choose this particular car model?

…………………………………………………………………………………

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………………..

Q15. Which of the following safety features or devices are in your vehicle apart from seat belt?

1. Air bag ( )

2. Electronic Stability Control (ESC) ( )

3. Antilock Braking System (ABS) ( )

Q16. Can you think of any safety feature that is not on your vehicle?

…………………………………………………………………………………

……………………………………………...

Q17. Have you ever experienced the need for these safety features while driving? 1. Yes ( ) 2. No ( )

Q18. How confident are you in the safety of your car?

1. Very confident ( )

2. Fairly confident ( )

3. Not very confident ( )

4. Not at all confident ( )

Q19. Give reason(s) for your response above (Q18)

………………………………………………………………………………

………………………………………...

Q20. How confident are you that these features (ABS, ESC, Air bag) would work in an emergency situation

1. Very confident ( )

2. Fairly confident ( )

3. Not very confident ( )

4. Not at all confident ( )

Q21. How do you get to know that the devices are working/ or in control

1. An indication appears on the dashboard and goes off within a few seconds upon car start up ( )

2. The vehicle returned to the road when it geared off the road ( )

3. The driver could feel the braking occurring ( )

4. The car slowed down in an emergency situation ( )

5. An alarm sound goes off ( )

6. I have never experienced the working of these devices before ( )

Q22. What do you feel would be the benefit of having safety features installed in your vehicle? (**Tick one**)

1. Safety and driver security ( )

2. Crash reduction and prevention ( )

3. Better driver control and stability ( )

4. Reduced likelihood of going off the road or into the ditch ( )

Q23. What are the effects of these features on the driver? **(Tick one)**

1. Loss of control by the driver ( )

2. Driver may become dependent or reliant on the technology ( )

3. Driver may become overly confident and increase their risk-taking ( )

4. No effect ( )

Q24. If you were to buy a new vehicle now, which of the following would be most important to you? **(Tick only one)**

1. Safety features that are available (e.g. ABS, Airbag, ESC) ( )

2. Vehicle size ( )

3. Comfort and convenience ( )

4. Car make and model ( )

5. Car speed and power ( )

6. Added extras - sound system, GPS, power steering, cruise control ( )

7. The time taken to accelerate from 0 to 60 km/h ( )

SECTION D: EFFECT OF VEHICLE SAFETY DEVICES ON DRIVING BEHAVIOUR AND ROAD TRAFFIC CRASHES

In this section, you will be sharing your views on the effect vehicle safety devices have on driving behaviour and subsequently on road traffic crashes.

Q25. At what speed (km/ hr) do you feel comfortable driving with on the highway?

1. 60 km/hr ( )
2. 80 km/hr ( )
3. 100 km/hr ( )
4. 120 km/hr ( )

Q26. Why this particular speed choice?

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……………………………………………………………………………………

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Q27. Do traffic conditions make you drive slower than preferred?

1. Yes ( ) 2. No ( )

Q28. Does the presence of safety features in cars influence drivers driving behaviour? 1. Yes ( ) 2. No ( ) **If No please skip Q29**

Q29. How do you think vehicle safety features in cars would impact on drivers driving behaviour?

1. Encourage drivers to drive less carefully/ responsibly or to not pay enough attention ( )
2. Encourage drivers to drive faster and aggressively ( )
3. Allows a false sense of security/ safety ( )

How often do you do each of the following while driving your usual vehicle

Driving violation	VF	QF	VI	I	N/A
Q30. Drive especially close to the car in front as a signal to its driver to go faster or get out of the way					
Q31. Become impatient with a slow driver in the outer lane and overtake on the inside					
Q32. Cross a junction knowing that the traffic lights have already turned against you					
Q33. Angered by another driver's behaviour, you give a chase with the intention of giving him/her a piece of your mind					
Q34. Disregard the speed limits late at night or very early in the morning					
Q35. Drive even though you realize that you may be over the legal blood-alcohol level					
Q36. Have an aversion to a particular class or road user and indicate your hostility by whatever means you can					
Q37. Get involved in unofficial races with other drivers					

VF= Very frequently

QF= Quite frequently

VI= Very infrequently

I= Infrequently

N/A= Not applicable

Attitude towards vehicle and road infrastructure improvements

Attitude	SD	D	A	SA
Q38. Drivers rely too much on safety features in their vehicles				
Q39. It is important to have up-to-date safety features				
Q40. Vehicle safety improvements foster greater speed				
Q41. With vehicle safety improvements, drivers have no worry when driving on slippery roads				
Q42. More safety devices influences the desire to take risk				
Q43. Road improvements makes driving less taxing and thus reduces drivers concentration				
Q44. Lane and road width increase leads to increase in driver's speed				
Q45. More road lanes lead to more crashes				

SD= Strongly disagree

D= Disagree

A= Agree

SA= Strongly agree

APPENDIX II

Observation Checklist

Gender of driver	Car model	Driver risk taking behaviour (tailgating, red light jumping etc)