An Analysis of Road Traffic Accidents in Senegal: Trends and Causal Factors, from 2012 to 2016

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Dedication

This dissertation is dedicated to my deceased parents, Doudou CISS and Adama DIOUF, for their parently support in ensuring a good education for me all their lifetime. To my wife Seynabou DIOUF and all my children, Aissatou Ciss, Penda Ciss, Mariama Mouhamed Ciss, Mouhamed Ciss and Daouda Mouhamed Ciss. To all my siblings, cousins, nieces, nephews and friends

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Abbreviations

RTAs	Road Traffic Accidents
WHO	World Health Organization
MITTD	Ministère des Infrastructures, du Transport Terrestre et du Désenclavement
DTR	Direction des Transports routiers
DALYs	Disability Adjusted Life Years
AIDS	Acquired Immuno Deficiency Syndrome
HIV	Human Immune Virus
RTI	Road Traffic Injuries
ANSD	Agence Nationale de Statistique et de la Démographie
BAC	Bureau des Accidents de la Circulation
GNP	Groupement National des Sapeurs-Pompiers
RTFs	Road Traffic Fatalities
GDP	Gross Domestic Product
UN	United Nations

Abstract

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Road traffic accidents are one of the major causes of morbidity and mortality. It is projected that by 2020 they will be 3rd leading cause of global disease burden (WHO, Evidence, Information and Policy Report 2000). The situation is worse in African countries characterized by high densities of both vehicle and human population. The objectives of the study are to analyze the trends of Road Traffic Accidents at national level and Dakar from 2012 to 2016, to examine the causal factors associated with the road traffic Accidents' trends and to reduce the factors which generally cause Road Traffic Accidents. In

Senegal, one of the major problems faced by the Direction of Roads and Transportation is the issue of road traffic accidents.

The research further established an analysis of RTAs at National level and the Capital City, Dakar. Factors that are responsible for road traffic accidents leading to fatalities and injuries were also examined. Finally, the study investigated if there has been any significant reduction in the road traffic accidents occurrence rate within the five-year period in Senegal since the commencement of World Health Organization's Decade of Action for Road Safety 2011-2020. It was found out that most of the accidents occurred as a result of changes in human behavior, vehicle and road (environment). Among road users group, pedestrians under 13 are the worst affected followed by passengers and pedestrians above 20. It was found out that road accidents have decreased since the commencement of decade of action for road safety. The composition of road traffic injuries and fatalities since 2011 shows a reduction in the numbers of victims recorded. There was high significant value ($\alpha<.05$ and $\alpha<.1$) among all the categories of road users understudied. The differences observed were real and did not occurred by chance for the 5-year period (2012– 2016).

Keywords: Road accidents; Fatalities; Injuries; Road traffic; Casualties; Trends; Public transport; Risk compensation; Road users (pedestrians, passengers, drivers)

Chapter 1. Introduction

Road Traffic Accidents (RTAs) which are generally unintended and preventable are a common risk every day to life that can happen to almost every one, anywhere. The problem of Road Traffic Accidents is increasingly becoming a threat to public health and national development in many developing countries. RTAs contribute to poverty by causing deaths, injuries, disabilities, grief, and loss of productivity and material damages. The British Medical Journal of 11th May 2002 indicated that more people die on the road traffic accidents than from Malaria worldwide; and that RTAs cause about 1.2 million deaths and injury 10 to 15 million people a year in the world.

RTAs are the most frequent causes of injury-related deaths worldwide (Astrom et al. 2006). According to the World Report on Road Traffic Injury Prevention, (Peden et al. 2004), traffic accidents account for about 3000 daily fatalities worldwide. Statistical projections show that during the period between 2000 and 2020, fatalities related to traffic accidents will decrease with about 30% in high income countries. The opposite pattern is expected in developing countries, where traffic accidents are expected to increase at a fast rate in the years to come.

Worldwide reports reveal the problem of accidents being equally serious. According to research carried out by Pierce and Maunder (1998), under the

auspices of Road Research Laboratory in UK, they found out that, road accidents worldwide are estimated to a total of 20,000,000 victims for a time period which 70% of the accidents occurred in developing countries. The number of accidents per registered vehicles was 10% to 20% higher in developing countries than in the developed world. The more general reasons advanced by these researchers for an increase of accidents in developing countries were as follows: **1.** The rapid urbanization process in these countries, **2.** The high growth rates of traffic and **3.**the poor road conditions, **4.** The reckless driving, **5.** The non-adherence to the traffic regulations by the motorist and the traffic officers (due to corruption), **6.** And the majority of people in developing countries was dependent on public transport for their daily activities. In developing countries the public transport system such as particular vehicles, taxis, buses, minibuses, vans and trucks have a much higher accident than in developed countries.

In developing countries the proportion of serious injured and killed casualties are higher than in the developed countries. An analysis of cross sectional data on road traffic related deaths has shown that the poorest countries have highest road traffic related mortality rates (Soderlund et al 1995). In this analysis, many industrialized countries appear to have introduced interventions that reduced the incidence of road traffic injuries and improve survival of those injured (Soderlund et al 1995). In developing countries there are some

peculiarities regarding the accident profiles. A study done in Calcutta India, reported that there are some host (human) factors (such as the behavior of drivers, pedestrians) and seasonal factors (weather and time) that cause fatal road traffic accidents (Zhang et al (1998). Overall, most traffic accidents occurred on main roads (highways, national roads, regional roads) and in the majority of cases pedestrians were found to be at fault during crossing the roads (Majumder et al 1996).

Such examination should be undertaken, because traffic accidents have negative impacts on social and economic improvements in developing countries. In this problem there are many agents: **(1)** The police who are interested in legal enforcement **(2)** The insurance companies and vehicle owners in the monetary cost of road accidents **(3)** The accident victim and their relatives in those of lives or disability and related cost of medical care **(4)** the health care system and medical personnel who are responsible for the emergence treatment and life savings of accident victims (Asogwa 1992).

In Africa, the number of road traffic injuries and fatalities has been increasing over the last three decades. The WHO African Region had the highest rate of fatalities from road traffic injuries worldwide at 26.6 per 100 000 population for the year 2013 according to the 2015 *Global status report on road safety*. In 2013, over 85% of all deaths and 90% of disability adjusted life years

(DALYs) lost from road traffic injuries occurred in low- and middle-income countries, which have only 47% of the world's registered vehicles. The increased burden from road traffic injuries and deaths is partly due to economic development, which has led to an increased number of vehicles on the road. Given that air and rail transport are either expensive or unavailable in many African countries, the only widely available and affordable means of mobility in the region is road transport. However, the road infrastructure has not improved to the same level to accommodate the increased number of commuters and ensure their safety and as such many people are exposed daily to an unsafe road environment.

The 2009 *Global status report on road safety* presented the first modeled regional estimate of a road traffic death rate, which was used to statistically address the underreporting of road traffic deaths by countries with an unreliable death registration system. In the 2009 report, Africa had the highest modeled fatality rate at 32.2 per 100 000 populations, in contrast to the reported fatality rate of 7.2 per 100,000 populations.

In Senegal, road transport is the basic mode of transportation for goods and passengers; catering 90% of National freight tonnage and 95% of the transport volume. Despite the fact that the development of road systems and transport is an important factor in social-economic development, road accidents account for high death rates in the country and pose a threat to public wellbeing

and developmental progress (Down 1997). However according to the latest WHO (World Health Organization) data published in 2017 Road Traffic Accidents Deaths in Senegal reached 4,237 or 5.15% of total deaths. And the age adjusted Death Rate is 38.40 per 100,000 population ranks Senegal #17 in the world.

1.1 Objectives of the study

So far, many studies have been done in Senegal which may not give a clear picture on the trends, patterns and causal factors of RTAs. However the purpose of the study is to empirically do the analysis of the determinant trends, patterns and even causal factors of RTAs by comparing the different ones in the whole country, Senegal and its Capital city, Dakar. However the findings of the study will not only be useful to policy makers but students, researchers, drivers and pedestrians

I first analyze the trends of Road Traffic Accidents at national level and Dakar from 2012 to 2016, second examine the causal factors associated with the road traffic Accidents' trends in Senegal and its capital city, Dakar from 2012 to 2016 and finally reduce the factors which generally cause Road Traffic Accidents.

1.2 Research questions

In order to achieve the purpose of the research, the focus will be on these guiding questions:

(1) What are the trends of Road Traffic Accidents (fatalities, injuries and property damages) between the capital city (Dakar) and nation average from 2012 to 2016?

(2) What are the causal factors of the Road Traffic Accidents (fatalities, injuries) for 5 years in Senegal and its capital city Dakar?

Chapter 2. Overview of Road Traffic Accidents in Senegal

In Senegal RTAs have been increasing since independence in 1960 and they have been one of the top ten causes of death. For example, in 2013, the number of people killed by road traffic accident was equivalent to those who died due to malarial (which is 9th cause of death) throughout the country. Road traffic deaths and injuries has therefore been the key public health and development challenges of the country and will continue to adversely affect the livelihood of community and the economy of the country unless effective measures are taken to control the problem.

Road traffic accidents not only adversely affect the livelihood of individuals but also their family members, as it can lead households into poverty via the enduring effects of the episodes: the costs of medical care, treatment and loss of family's income generators. Road traffic accidents have also a gigantic impact on national economy by consuming the already inadequate resources, damaging invaluable property, and killing and disabling the productive age group of the community. In general, the severity of the problem is becoming horrific shockingly and reaching a catastrophic level showing that sufficient work has not been done to control and/or reduce alarming rate of the accident. This also implies

that timely, accurate, and relevant data need to be collected and analyzed periodically so as to examine the trends, scope, and severity of the problem and come up with reasonable solution(s). The aim of this paper is thus to scrutinize the trends, causes, and economic implication of road traffic accidents in Senegal.

2.1 Study area: Location and general Characteristics

This part presents the background information about the study areas. It begins by giving a broad overview of Senegal and its Capital City's profile with emphasis on geographical, demographic and socio-economic aspects relevant to the study. This part presents a detailed description of Dakar as the specific study area.

2.1.1 Brief Country Description

2.1.1.1 Geographical and Demographic Data:

Senegal is a country in western Africa. Located at the westernmost point of the continent and served by multiple air and maritime travel routes, it is known

as the “Gateway to Africa.” The country lies at an ecological boundary where semiarid grassland, oceanfront, and tropical rainforest. According to 2010 census, Senegal with the total area of 196,722km2 had the total population of 15.5 million giving the population density of 82.83 people per square kilometer (ANSD, 2017).

There are fourteen (14) regions in Senegal and Dakar is geographically the smallest but the most populous one. According to (ANSD, 2017 census), Dakar region had the population of 3,200,000 and population density 77,388 people per square kilometer. Although still high, poverty appears to have fallen in recent years. A 2010 survey (the most recent) calculated the poverty rate at 47 percent, but poverty appears to have fallen by 4 to 7 percent since due to good economic growth. Senegal ranked 164 of 188 countries in the global 2017 Human Development Index (based on 2015 data), but has one of the largest safety net programs in Africa, covering 30 percent of its poorest households.

It has made progress on child health, mostly by addressing malaria and chronic malnutrition (stunting), which at 17 percent is now the lowest in continental sub-Saharan Africa. Not as much progress has been made in maternal, neonatal, reproductive, and adolescent health, where key indicators are lagging behind. A barrier to improvement, especially among the poorest Senegalese, is the relatively high cost of healthcare. In 2013, Senegal launched its Universal Health

Insurance program to improve equity in access to health services, especially among households in the informal and rural sectors. The coverage rate is slowly increasing but remains far from the government's target of 75 percent of the population by the end of 2017.

After decades of very modest growth, the Government of Senegal adopted the Plan Senegal Emergent (PSE) in 2014. The development plan is designed to get Senegal out of a cycle of low-growth and weak poverty reduction. Preliminary figures put Senegal's economic growth at 6.8 percent by 2017—the third year in a row of a growth rate of over 6 percent. Implementation of the plan, which boosted public investment and promoted private sector activity, helps explain this, plus a growth-conducive macroeconomic framework and favorable exogenous conditions (good weather, relatively low oil prices). Despite high growth, inflation remains low and under control.

The primary sector of the economy is the most dynamic, growing at over 7% (due particularly to agriculture), but the secondary sector is picking up and expected to take the lead in a few years' time. On the demand side, exports and total investment have been the fastest growing components. Senegal's macroeconomic framework remains solid, though; small cracks are emerging, underscored by rising debt levels and liquidity constraints. So, although the fiscal

deficit has fallen—from 4.2 percent of GDP in 2016 to 3.7 percent in 2017—a large investment program, rising energy prices (that increase energy subsidies while reducing revenues from frozen gasoline prices), and Treasury operations that have financed deficits in other public entities are all placing pressure on the fiscal balance. In consequence, the government delayed some payments to suppliers in 2017. Public debt has also continued to increase, though at a slower pace, to 60.8 percent of GDP in 2017, while debt servicing increased from 24 to 30 percent of government revenues between 2014 and 2017.

2.1.2 Road network in Senegal

About 90% of movements of people and goods in Senegal are made via roads. The roads network is estimated at about 14,500 km, of which 4,500 km are paved. In fact, it is now possible from Dakar to reach any of the other ten Senegalese main regional cities by paved road.

2.1.3 Dakar (Capital City)

Dakar is located in the western part of Senegal. It has an area of 83 km2 and it shares boundaries with Thies region and the Atlantic Ocean (see fig3). Dakar has a generally flat topography with an elevation ranging from 1200 to 1300 m above sea level (ANSD, 2016).

There are mainly two seasons in Dakar and Senegal as a whole: dry and wet (rainy) season. The rainy season is the one with greater influence on the road traffic and safety due to slippery road surfaces and sidewalks which are flooded with rain water forcing people to walk in main roads together with heavy traffic. Dakar between December and May is usually pleasantly warm with daily temperatures around 24–27 °C (75–81 °F). Nights during this time of the year are comfortable, some 17–20 °C (63–68 °F). However, between May and November the city becomes decidedly warmer with daily highs reaching 29–31 °C (84–88 °F) and night lows a little bit above 23–24 °C (73–75 °F). Notwithstanding this hotter season Dakar's weather is far from being as hot as that of African cities inland, such as Niamey and N'Djamena, where temperatures hover above 36 °C (97 °F) for much of the year. Dakar is cooled year-round by sea breezes.

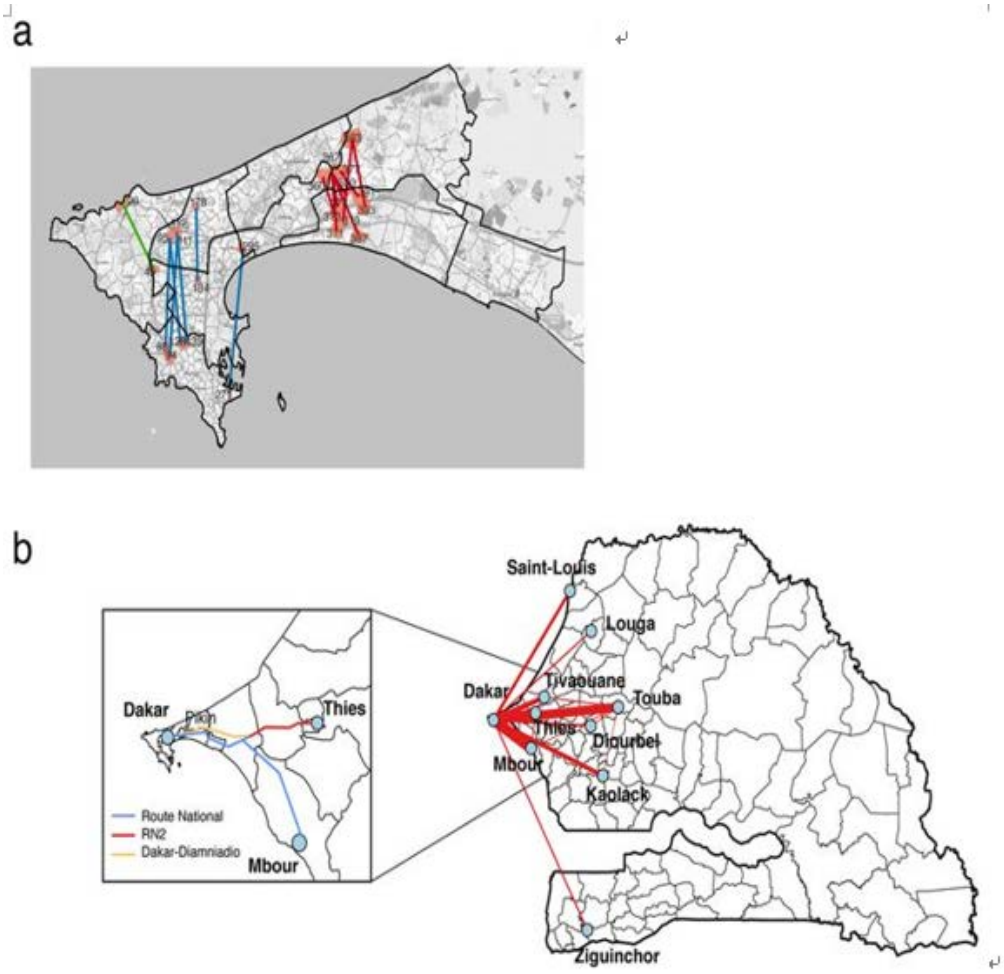

Figure 2.1 Location Map of Dakar in Senegal

Source: World Bank (2013)

Dakar is the most urbanized region in Senegal with a population of 3,200,000 which is about 20.7% of Senegal's total population and the density of 77,388 persons per km2 (ANSD).This population density has implications on road

safety. One of the implications of higher population density is that it leads to higher per capita expenditure especially on public safety whereby the local government may not provide road infrastructures (sidewalks, pedestrian crossing lanes, speed humps and appropriate road signs at the fast rate of population growth. The other implication is that there is an increase in the number of pedestrians crossing roads which results in higher risk exposure. Others social services such as markets may not be adequate forcing vendors to be selling from parking slots, pavements and main roads. Dakar being urbanized also implies it's a car-oriented city and that people use public transport for most of their daily activities hence exposed more to the traffic system.

2.1.4 Road traffic situation in Senegal

Dakar accounts for a bigger percentage of all registered vehicles in Senegal. According to ANSD (2017) out of registered vehicles in Senegal, 358,832 (84%) were registered in Dakar alone and car owning households accounted 25% of the total households in Dakar. The screen Line Traffic Survey conducted in 2015 indicated that more than 60,000 numbers of vehicles per day were observed on the major trunk roads with about 90% dominated by passenger traffic using cars, taxis and buses (Direction of Transportation).

The problem of RTAs was on the increase for the last thirteen years, 52,397 from 2000 to 2013. In 2011, the total number of road accidents was estimated to 3,223(6.15%) and it had increased to 5046 (9.63%) in 2013which constituted a very important increase.

According to the "Direction of Land Transportation's Annual Report 2016", in Senegal, the number of vehicles on the roads has greatly increased due to government liberalized policies (689,033 vehicles in 2016-ANSD). Unfortunately road maintenance, driver's education, vehicle upkeeps and traffic regulations have not grown accordingly. A high accident level increases the dependency burden of the country. Working parents are killed or injured in traffic accidents leaving children who relied solely on these deceased people for sustenance. Causalities from traffic accidents impose a heavy burden on the specialized health care facilities. In addition, the cost of repair and replacement of damaged vehicles demand resources that otherwise could be devoted to high priority human development sectors such as education, food production and health. Thus, many countries pay dearly the cost of the modernized transport system and increased mobility in the absence of compensatory mechanisms for ensuring safety. The total of road accidents has been estimated to be more than one percent of GNP in developing countries. (Down 1997)

It is estimated that Senegal was losing CFA 77 billion every year as property loss, treatment expenses and road damage as a result of road traffic accidents. It is also estimated that the loss experienced by Senegal is twenty times greater than developed countries like France which has more number of vehicles than Senegal. (Direction Land Transportations-2007).

Chapter 3. Theoretical Review

In this chapter we begin to present the theories and approaches that have been used in this study and an analytical framework which shows the areas where this study will focus from each theory or approach. Road traffic accidents fatalities and injuries have multiple causal factors and are quite a varied issue and accepting them requires a combination of theories and approaches. This research has used two main theories and two approaches. The chapter also provides a review of relevant literature to this study. Literature from both developed and less developed countries have been used but more focus was on studies from less developed countries with special attention on Africa which provides similar context to the study area, Senegal.

Most research in human geography especially those associated with human-environment relationships are multi-faceted and complex and may require a combination of paradigms, approach and concepts. This study has used two theories and one approach. These are system theory, risk theory, model of traffic accidents causation and geographical approach to road traffic causation.

3.1 The System theory of road traffic accident causation

The System Theory of road traffic accident causation explains the man-environment adjustments and maladjustments. The basic assumption of the systems theory is that road traffic crashes result from the interfacial malfunctioning of the components of the traffic systems. The main emphasis is on man-environment adjustments and maladjustments (Muhlrad & Lassarre, 2005). Hence, human factors and vehicle factors combine with physical and social environmental factors to bring about road traffic accidents. The interdependence of these factors in relation to accident causation suggests that in trying to investigate the causes of road crashes all the relevant factors within the system ought to be given (equal) attention. According to Peden et al. (2004) " the system approach seeks to identify and rectify the major sources of error or design weakness that contribute to fatal and severe injury crashes , as well as to mitigate the severity and consequences of injury".

The system based models assumes that accidents which occur in a complex socio-technical system are caused by a range of interacting human and system failures (Aderamo, 2012). The System Theory focuses on three main components: vehicle, behavior and Roads (environment). The vehicle component of the theory describes motor vehicle composition, age, its technical aspect

(condition of tires) and safety equipment like air bags and seat belts. The behavior of man component comprises of demographic characteristics which include age, sex, attitude, general traffic behavior, driving experience and driving styles including rule violation such as over speeding and others. The environment component comprises of the natural, social-cultural, built-up environments and road environment (transport networks). Time of the day, settlement pattern and land use are all part of the environment in the system. The system traffic laws, controls and regulations were superimposed to the system theory in the model for traffic accidents.

3.2 The Risk theory in road traffic accident causation

The risk theory in road traffic accident studies has also been used to describe accident causation and identification and implementation of countermeasures. According to Moen & Rundmo (2005) risk can be defined as "the likelihood that an individual will experience the effect of danger". The word risk therefore, carries both probability of a negative event and the consequences of such an event. Risk increases as the probability increases and as the expected consequence increases (Moen & Rundmo, 2005). According to (Peden et al.,

2004), road traffic accident risk is a function of four elements: amount of exposure-that is the amount of movement or travel within the system by different road users; probability of crash given a particular exposure; probability of injury, given the crash and the outcome of injury. In Table Peden et al. (2004) also outline three main areas of risk factors based on risk theory.

Table 3.1 Main risk factors of road traffic accidents based on risk theory

Factors influencing exposure to risk	Factors influencing crash involvement	Factors influencing crash severity
Economic factors (poverty), demographic factors (age, gender, education & marital status), land use pattern, speed limits and road design & type	Excessive speed, being young male, poor vehicles: maintenance (tyres' conditions), inadequate visibility, ignorance of the traffic laws.	Human tolerance, excessive speed, non-use of vehicle facilities, bad weather conditions.

Source: Adapted from Peden et al (2004).

The risk theory in road traffic accident causation may be more applicable to less developed countries where large part of the population is exposed to public transport system for their daily activities. They are exposed as passenger, pedestrian or cyclists. Peden et al. (2004) argue that, "in terms of exposure to risk, the main modes of travel in these countries in the foreseeable future are likely to

remain walking, cycling and public transport". This large amount of exposure may lead to high probability of injury and severe injury outcome. In these modes of travel, there are major variations in risk of injuries existing among pedestrians, cyclists and bus passengers (Peden et al., 2004). Nordfjærn et al (2011) observed that poor countries exhibit a higher risk tolerance because of being exposed to various risks every day. It is very likely that people in poor countries can neglect traffic risk due to the influence of other existing risks such as HIV/AIDS, malaria and hunger.

3.3 Model of traffic accidents causation

This part deals with the system theory of traffic accidents causation and it will be used with its key components of system of traffic laws, control regulation and as well as looking at aspects of behavior, vehicle and the environment. Traffic laws and regulations will help to highlight on the countermeasures. This model was developed by Jørgensen-Abane (1999) and it draws spur from both the system theory and the social ecological model. The model tries to propose that dealing with risk factors and prevention measures, four aspects should all be considered. These are the vehicle, behavior, physical environment and traffic

regulations and control. The strength of this model is in its holistic approach to road traffic accident causation. All categories of road users are covered and it adds the policy making and implementation aspect. The path line arrows in the figure 1 show direction of influence and nature of relationship among the different elements of the model.

(1) Human behavior

The behavior of the population includes socio-demographic characteristics like profession and education. The model considers the attitude and behavior of road users (drivers, pedestrians and passengers) as being key causal factor in road traffic accidents. For instance a pedestrian who crosses outside crosswalks or a driver who does not obey traffic rights or speed limits can pose danger to other road users. Other aspects of the behavior are training attained by the driver or driving experience, driving under influence of alcohol or drugs. Some minibus drivers do not go to formal driving schools instead they learn driving while working as conductors leading to acquisition of driving licenses by corrupt means. All these pose great danger to other road users.

Attitude in traffic (rule violation) and risky driving behavior Attitude towards rule violation in traffic is associated with risky driving behavior such as reckless driving, drink and driving and seat belt user (Iversen, 2004). According

to Iversen and Rundmo, “attitude towards traffic safety were associated with involvement in risk behavior, especially attitude concerning rule violations and speeding and reckless driving”. Horwood and Fergusson (2000) also found that driving without skills to be one of a constellation of risky driving behaviors that may include speeding, unsafe and careless driving and also found that the high rates of accidents reflect a general tendency to risky driving. In a study of road accidents in Kenya, Muchene (2013) found that commercial drivers have been blamed for careless driving, drunken driving, incompetence, over speeding and other myriad of attitude and behavior that render them prone to causing accidents which could have been avoided. In the same study pedestrians were also known for flouting traffic rules by crossing the roads at non-designated points even failing use fly-over and underpasses foot bridges. Kobelo et al (2013) also argued that “the contributing human error in causing crashes is not only confined to drivers but also to passengers and pedestrians.” There are cases where pedestrians cross the roads in undesignated places or penetrate in between cars in congestion. Passengers may also stop and board a bus or lorry on any part of the road where there is no bus stop and can even get on an overloaded vehicle just to rush for their urgent issues disregarding the risk.

Socio-demographic characteristic factors:

- Age and gender

Studies examining dangerous driving have shown that gender is significant in predicting involvement in accident (Iversen & Rundmo, 2004; Nordfjærn et al., 2012; Yagil, 1998). Growing number of studies have shown that socio demographic characteristics have an important relations to driver attitude and behavior (Nordfjærn et al, 2012). A global fatality study found that females rarely account more than 25-30% of road casualties in developing countries but females instead tend to have higher pedestrian involvement (G Jacobs & Aeron-Thomas, 2000). Females are more involved as pedestrians and passengers in Africa probably due to cultural attitude where more males take driving jobs than females and males are economically able to buy cars than females hence males are more exposed as drivers. The few females that drive only do it for shorter distance (few kilometers) such as when going for work or shopping hence less exposure.

A study done by Turner and McClure (2003) in Australia showed that male drivers, aged 17-25 years, were involved in 75 % of fatal road crashes both in 1999 and 2000. Ackaah and Adonteng (2011) also found that in Ghana about 74.3% of fatalities involving males. Young males aged 15-44 years are more affected and 50% of global mortality occurs in this age group (Hazen & Ehiri, 2006; Odero et al., 1997; Sharma, 2008). Males engage in unsafe driving

behaviors such as driving with speed more than females (Nordfjærn et al., 2012; Yagil, 1998). In a study of gender and age related attitudes toward traffic laws and violation, Yagil (1998) attributed the gender difference in traffic behavior to socialization process and gender roles where girls are encouraged to be obedient and dependent while boys are allowed to be independent. Women's role is passive and non-competitive as a result they are not expected to take risks. Males are encouraged to express anger, take risk and compete hence they may commit more driving violations than females.

- Marital status

In a study on age and gender differences in risk-taking behavior, Tuner & McClure (2003) found that those never married showed higher driver aggression scores. The married and divorced/separated were not different in driver aggression scores. The single people are usually young people who are more likely to take risk because they have no families to take care of.

- Education

Education is an important variable for driver attitude and behavior. Studies found that the use of vehicle facilities differed significantly among young and

illiterate drivers with different levels of educational achievement or almost none (Hoseth & Rundmo, 2005; G Jacobs & Aeron-Thomas, 2000). Another study (Hoseth & Rundmo, 2005) found that individual with higher education demanded less transport risk mitigation which could mean they are more liable to take risks. While gender and age predicted driver attitude and behavior, education was a weaker predictor (G Jacobs & Aeron-Thomas, 2000). Lourens et al (1999) found no significant relation between educational level and accident involvement. Tuner and McClure (2003) found higher mean scores on driver aggression for those who had completed university education. Increased frequency of driving drowsy was associated with demographic characteristics like younger driver, high education and men (Mc Cart et al, 1999) while Dobson et al (1999) also found that higher socio-economic status (Education & occupation) was associated with driving lapses and errors. Vulnerable road users Most of road traffic studies, in Africa and Asia, show that pedestrians and passengers are most vulnerable road users accounting about 80% of road fatalities (Aderamo, 2012; Chen, 2010; Nantulya & Reich, 2002; Odero et al, 2003; Sharma, 2008). Pedestrians alone accounted between 41 & 75%, passengers between 38-51 % (Ackaah & Adonteng, 2011; Lagarde, 2007; Odero et al., 1997).

(2) Vehicle

It presumes that the condition of the vehicle being used on the road is a factor responsible for the number of accidents. These conditions include old vehicle, brake failure, poor state of tires (which can lead to bad tyres' conditions) and poor maintenance of the vehicle by using cheap and old spare parts. Other aspects of the vehicle include inside protective mechanism such as seat-belts and airbags. Some studies have shown that there is a positive relationship between increasing road traffic crashes in developing countries and poverty. Chen (2010) argues that the majority of Africans use public buses for daily routine as passengers which expose them to risk of collision and injury. These vehicles usually have no seat belts since they are imported as second hand vehicles (Chen, 2010). Hazen and Ehiri (2006) observed that socio-economic factors indirectly contribute to and worsen road casualties. Most of the poor are among the vulnerable pedestrians or passengers on unsafe public transport. Odero et al. (1997) argue that, "a high prevalence of old vehicles that often carry many people than they are designed to carry, lack safety belts and helmet use, poor road design and maintenance and traffic mix on roads are other factors that contribute to the high rates of crashes in less developed countries". It was also observed from other studies (Aderamo, 2012; Chen, 2010; GD Jacobs & Sayer, 1983) that most of the

vehicles in developing countries are defective, lack maintenance and use low quality spare parts which contribute to road traffic crashes.

Economic growth demands an adequate transport infrastructure. Overloaded vehicles, especially freight vehicles, are destroying our roads, impacting negatively on economic growth – the damage caused grows exponentially as the load increases. Damage to roads as a result of overloading leads to higher maintenance and repair costs and shortens the life of a road which in turn places an additional burden on the state as well as law-abiding road users who ultimately carry the costs of careless and inconsiderate overloading. If the problem of overloading is not controlled, this cost has to be carried by the road user, which will require significant increases in road user charges such as the fuel levy, vehicles license fees, and overloading fees to mention just a few. Overloading is a safety hazard that leads to unnecessary loss of life, and also the rapid deterioration of our roads, resulting in increased maintenance and transportation costs (Chen, 2010)

(3) Road (Environment)

The model considers the physical environment (road) to be one of the key factors in RTAs as it influences both the road user and vehicle. It relates to all

external surroundings of the road system, the road types and built up environment. All aspects of the physical environment were further classified as; visibility (daylight, night without lighting and night with lighting) and climate referring to weather conditions (normal, raining, storm, fog and others). Also spatial conditions in terms of arrangements and macro-structures, settlement distribution pattern (urban or rural/ sparse or populated area), situation of areas of residence and working areas.

For instance potholes can influence the driving behavior. Other aspects are type of road (highways, national roads, regional roads and urban roads). The physical environment also looks at spatial conditions (structures), settlements pattern and topography like uphill or downhill and road bends which expose road users to higher risk of road traffic accidents. One characteristic of physical or built environment which is common in less developed countries (due to poor economic situations) is lack of traffic separation for motorized and non-motorized road users. This makes pedestrians to walk close to or on the main road especially in rainy season when the sides of the road are covered by pools of water. The socio-cultural environment looks at people's attitude in traffic safety. In most of less developed countries a lot of people are not in formal employment hence they live stressful lives as they struggle to earn a living. When in the city, they are very busy with ways of making money and usually neglect traffic safety. Some of the

people are involved in businesses which are conducted in illegal locations such along the street. The other aspect of traffic culture neglected in less developed countries is none use of retro-reflective attires when it gets dark. These attires could indicate to motorized road users about pedestrians crossing the roads. This is worsened by poor street lights yet most of the people walk along these roads as they knock off from work and their business in the city. Although it is not a culture of using bicycles and motor cycles as means of transport in some less developed countries like Senegal, the few that ride rarely use helmets and reflectors. They sometimes ride on the main road due to lack of cyclist lanes in some places. Those who use personal cars are usually in hurry to get to work because of traffic congestion hence do not exercise patience when driving which result in collisions with other cars or pedestrians and cyclists.

Traffic laws, regulations and controls:

The element of traffic laws, regulations and controls was superimposed by the model as a fourth element. It included policy making and implementation process which plays a fundamental role in road crash prevention. The vehicle, behavior and environment elements can, to a large extent, are influenced by traffic laws and enforcement. The level of regulation and control will determine vehicle conditions, behavior of road users and condition of the road. There is a two way influence between each pair of factors. For instance the vehicle will determine

how a driver behaves such as a new vehicle makes the driver over speed. People‘s behavior or attitude will also determine the type of vehicle they buy i.e. a vehicle with no airbags. The environment (nature of road) will influence the driving behavior and vice versa. The vehicle condition, nature of environment and behavior to some extent may also influence the traffic regulations to be adopted hence small dotted arrows indicating little influence in that direction

Corruption and traffic law enforcement:

There is poor enforcement of safety regulations in less developed countries (Sharma, 2008). Corruption has been seen as a distal (distant) contributing factor to road traffic crashes especially in the area of law enforcement by police and on issuance of drivers' license. Nordfjærn et al. (2012) argue that, "countries in Sub-Saharan Africa usually have fewer explicitly defined road traffic regulations and less enforcement of these regulations due to lack of resource and high levels of corruption". Kobelo (2013) also argued that, "corruption is one of the major impediments to success of road safety efforts. For example, learner's driver license and driver's licenses are issued regardless of whether the person has the required knowledge and skills to operate a vehicle on the road". There are some cases where traffic police were seen, on camera, receiving bribes from traffic law breakers and allow such drivers to go free (Muchene, 2013). "Corruption is a huge

problem in some countries often creating a circle of blame-police blame -driver, public blame drivers and police and drives blame police. Corruption also extends to vehicle and driver licensing agencies" (Nantulya & Reich, 2002).

In summary it can be argued that all factors contribute to accident causation. Odero et.al (2010) studying road traffic injuries in Kenya, identified major causes of road crashes as being human factors (85%), vehicle factors (5.1 %), road environment (2.9%) and other factors (6.4 %). On the other hand, Kobelo, et al (2013) found road design deficiencies, human factors and lack of proper enforcement as contributing factors to unsafe road ways in Tanzania

3.4 Geographical approach to road traffic accident causation.

In addition, the geographical approach to the study of traffic accidents relates to the concepts of place, time and environment of accident occurrence. The key elements are land use and road elements such as width, bends and topography (i.e. hilly, slopes) and regional distribution in occurrence of road traffic accidents. Jones et al. (2008) argue that the study of road traffic accidents should focus on wider areas rather than just sites with highest crash frequencies. The geographical approach examines the context of the environment within which road crashes

occur. This approach also looks at population densities, economic activities and land use effects on road crashes. The other multifaceted elements of the geographical approach are residency population, demographic characteristics such as age, gender and socio-economic of a population, traffic volumes and road length. Jones et al. (2008) state that, "the physical structure of the road network, expressed in terms of the curvature or sinuosity of road and frequency of junctions, may influence road traffic accident risk". This means that the road density, road bends and junctions are usually associated with risk of crashes. The geographical approach also looks at spatial distributions of population such as urban and rural and high and low residential areas may influence their vulnerability to traffic risk.

Although the geographical approach looks at road traffic accidents from a broader perspective, this study will only focus on demographic characteristics like age, gender and high or low residential areas. Other aspects will be road density, junctions, traffic volumes, time and day of occurrence.

Physical and socio-cultural urban traffic environment in less developed countries.

In relation to geographical approach, urban areas in less developed countries are characterized by high volume of traffic causing traffic congestions and higher risk of vehicle collision especially at cross roads or junctions. The other characteristic of urban traffic environment is high number of pedestrians

both in city center and residential areas. In most less developed countries, as argued by Sharma (2008), there is poor road and land use planning characterized by mix of high speed traffic, heavy commercial vehicles, pedestrians and cyclists with no pavements and cyclists lanes. This is argued further by Chen (2010) and Nantulya& Reich, (2002) who cited poor road design, overcrowding and hazardous road environment in developing countries. This complex road user environment creates more potential conflict between vehicles and vulnerable pedestrians (Jørgensen, in press). Businesses conducted in undesignated areas especially along the shop corridors and on road pavements create a higher risk exposure to the street vendors.

Urban-rural disparities.

Road traffic studies have shown that there are variations in pattern of road traffic accidents between urban and rural areas. Jorgensen (in press, p.167) argues that, "risk exposure will vary geographically, influenced by motorization, transport mode use and travel distances on the one hand and transport context, time and place and speed conditions on the other hand." This implies that densely populated areas in terms of vehicle densities and road users are more likely to have more but less severe crashes while sparsely populated (rural) areas are more likely to have fewer but more severe crashes. High traffic volumes, speed limit,

roundabout, traffic lights and junctions may lead to reduced speed in urban areas while speed increases in rural (high ways) areas with higher speed limits, less traffic volumes and fewer pedestrians crossing the roads. In the study of pattern of road traffic injuries in Senegal, Afukaar et al (2003) found that pedestrian fatalities accounted for about 66.8% in urban areas and 33.5% in rural area. But the car occupant fatalities were 8% in urban and 11.1 % in rural areas. Bus and minibus occupant fatalities were 8.9% in urban areas and 28.5% in rural areas. Odero et al. (2003) found that 60% of all injury-producing crashes occurred on road in rural areas while 40% occurred in urban areas in Kenya and these were attributed to greater number of buses and minibuses that are involved in crashes. The same study also found that road user involvement varied between urban and rural areas. 68% of fatalities of pedestrians were in Nairobi (urban) whereas in other (rural) provinces, the majorities killed were passengers (Odero et al., 2003). This shows spatial variation in road user fatalities between urban and rural areas by mode of transport. This could be explained by less population density (fewer pedestrians) and posted high speed limits in rural areas leading to severe fatalities compared to urban areas. Other factors could be less presence of police leading to more rule violation such as reckless driving.

3.5 The empirical studies of Road Traffic Accidents

Different circumstances precipitate car accidents in Senegal. Understanding these contexts (political and socio-economic) gives a better understanding of why road accidents have remained a leading cause of death in the country

3.5.1.1 The political context

Road Traffic Accidents in Senegal may not be directly attributed to politics. However governance, budgetary allocations, contract evaluation, etc. have direct impact on the rate of fatal car accidents in Senegal. Operations of government and parastatals into safety measures and road accidents' control have mostly been frustrated by poor funding.

The Ministry of Infrastructure, Land Transport and the opening up (MITTD) and the Direction of Road Transport (DTR) suffer from an apparent lack of priorities and severe budgetary constraints leading to insufficient human and material resources and untimely acquisition of safety equipment. Further bureaucratic logjam and politicization of the award of contracts are marred with irregularities and inflated costs. This situation leads to a situation where road contracts are either abandoned or poorly constructed and do not meet up with international

standards. Commuters are mostly raided by armed robbers in bad portions of the roads where vehicles come to a halt.

3.5.1.2 The economic context

The rapid development of comprehensive road transportation systems is crucial to the economy of every nation. Opportunities to acquire and sell a variety of commodities necessary for industrial and manufacturing systems are expanded by a well-coordinated transport system. According to Oni (2004), transport is a key element in the social and economic development of any nation. The restrictive nature of the water ways, the pitiable conditions (even inexistence) of the rail system, and the inability of a Senegalese average to afford the high cost of air travels made road transportation preferable in Senegal.

Over 70 percent of the total movements of the registered vehicles in the country and about 80% of the freight movements are done on the roads. The over dependence on road transportation keeps worsening the condition of the roads and mounted huge pressure on motorists. These frustrations have direct and indirect impacts on number of road accidents in Senegal.

Previous studies reveal that owners of public transport vehicles, in pursuit of increased profits, frequently force their drivers to drive at excessive speeds, to

work unduly long hours and to work when exhausted. According to Alassane Ndoye, most commercial drivers are paid daily wages which range from CFA2500 to CFA5000 depending on the city and the type of vehicle, which they considered meager. After daily or weekly account as the case may be, such drivers are left with meager income that cannot sustain them and their families. Under such circumstances, cars are less maintained and drivers tend to over speeding in order to cover more trips. The risk of being injured, according to Agbonkhese et al, increases exponentially with speed much faster than the average speed and the severity of accident depends on the vehicle speed change at impact and transfer of kinetic energy.

3.5.1.3 The social context

Poverty remains circumstantial in the occurrence of road accidents in Senegal but may not be directly linked to it. Poor housing conditions, social isolation, notorious indiscipline, overloading of passengers in all areas, insecurity in public places and few other variables explain why the risk of road accidents remains high among low-income earners in Senegal, against the rich ones that reside in metropolitan areas with overhead bridges, secured play grounds, traffic control and safety measures. Christie (1995) argued that a link between social

deprivation and the high accidents' rate may be explained in terms of increased exposure to hazardous environments. This assumption was expanded by Abdalla (1997) when she argued that the casualty rates amongst residents from areas classified as relatively deprived were significantly higher than those from relatively affluent areas. Schools located next to roads lack overhead bridges and pupils and pedestrians are left at the mercy of careless drivers. Instances were seen in all areas where school children were crushed to death while trying to cross the expressway. Whereas parents cannot afford the huge fees paid by the high-income earners, they send their children to schools where they are exposed to fatal road accidents Population density is a factor that influences the frequency and fatality rate of car accidents in large cities. Slump areas of often congested with peoples and vehicles. Lack of space encourages the dumping of wreckages on the roads. While drivers scramble for space and try to outsmart their opponents, their inflated driving skills can lead to fatal accidents. Whereas safety measures are ignored, people frequently lose their lives. Car accidents that occurred in large cities like Dakar and some cities or some areas of the country mostly lead to severe fatalities. Social analysts have argued that accidents happen more during festive periods and weekends, even Mondays. This assumption is linked to social driving which involves driving to and fro social events, driving with peers and driving late at nights. Most victims of fatal roads accidents are youths who are

most enticed with social events. Smat Detal (moos) noted that limited driving experiences, night time driving, and fatigue are particular risks for young men. Social occasions, religious festivals (Magal festival, Maouloud festival, Poponguine Pilgrimage) and travel back to work places on Sunday increase traffic volume and the probability of having a car accident. It is also noticed that high incidences of road accidents on Friday and Saturday when people leave their workplaces to spend their weekends with friends and families. Emotional stress such as personal relationships, family problems, and financial problems are important elements in the occurrence of road accidents. Drivers' capacity to attend to hazards is mostly defined by his state of mind. Phone conversation while driving, interacting with peers undermine driver's sense of judgment and responses. These in-vehicle distractions increase the likelihood of entirely missing critical events such as changes in traffic lights (Hancock Lesch Simons, 2003). Furthermore, drivers who are gripped with negative emotions exhibit a high level of distraction. They experience impaired observations and fail to recognize instructions such as traffic or debris on the road and engage in risky maneuvers, changing lanes and driving on freeways. Such distractions lead to road rage, distractions that may be unacceptable by road users.

Chapter 4. Methodology and Analytical Framework

This chapter is one of the most important parts of the research because we should have a plan about what are we going to do. It is mainly explaining how this study is conducted, the applied methods and techniques in data collection and the reasons as to why they are used according to the research aims and main objectives of the study. According to Webster (1985), to research is to search or investigate exhaustively. It is a carefully or diligent search, studious inquiry or examination especially investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws. It can also be the collection of information about a particular subject.

This chapter will involve a discussion of the conceptual framework, the research method, the study areas, justification and sources of data used in the study. There will also be a discussion on the analytical and statistical techniques used in analyzing the data for the study. This chapter concludes with the discussion on the methodological problems encountered during the data collection and analysis.

4.1 Methodology

The Dictionary of Sociology (1998) defines methodology as “the methods and general approach to empirical research of a particular discipline”. It has implied that various methods exist to approach a particular research problem, and the researcher should give his or her own set of methods considerable thought. (Beiske, 2007). This research used the quantitative method in order to analyze the data. Quantitative method emphasizes on the objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires, and surveys, or by manipulating pre-existing statistical data using computational techniques.

The research was descriptive in nature to enable the researcher to analyze the trends and the causal factors of Road Traffic Accidents in Senegal by comparing it to its Capital City, Dakar. The purpose of the descriptive type of research is to illustrate the information on the existing conditions. The research was conducted using secondary data focus on the national data and the capital city one. The data analysis method used in this research was systematic grounded theory. The collected data was cleaned, grouped, coded and entered in the Microsoft Excel 2013 software package and statistical software called Statistical Package for Social Science (SPSS). All data were rechecked to minimize the entry

error. All the statistical analyses were performed using Microsoft Excel 2013 software package and SPSS version 23. Differences and results were considered significant at $\alpha < .05$ and $\alpha < .1$.

The researcher captured the data on RTAs on Microsoft Excel, where mean of five-year period and rate were performed. Mean of five-years and rate were used to evaluate data obtained from technical reports on road traffic accidents within the national level and Dakar. The data findings were presented on graphs and charts. This was followed by a comparative analysis of road traffic accidents (injuries and fatalities) amongst the national level that comprise Dakar. Factors that were identified as causal to road traffic (injuries and fatalities) were categorized under themes using factorial analysis approach.

4.2 Analytical framework

An analytical framework can be described as a tool that aids thinking and executing any given task or research. It outlines the underlying methodologies, principles and rationale for a particular concept or project. It is known that a good analytical framework tends to be simple and shows what is important. It should inspire the researcher to take actions that will address complex and challenging

issues. With respect to the above explanation, the analytical framework for this study will be to consider a model for road traffic accidents.

A human ecological theory, which focuses on the human as a social being in interaction with his/her environment, can be modified to suit the study of road traffic accidents. The model comprises of the three main components considered in road traffic accidents:

- The vehicle: this takes into consideration the vehicle composition, type of vehicle and vehicle technical conditions (tyres' conditions)
- The road (environment): this relates to all external surroundings of the road system, the road types and built up environment. All aspects of the physical environment were further classified as; visibility (daylight, night without lighting and night with lighting) and climate referring to weather conditions (normal, raining, storm, fog and others). Also spatial conditions in terms of arrangements and macro-structures, settlement distribution pattern (urban or rural/ sparse or populated area), situation of areas of residence and working areas.
- The behavior of the population: this includes the socio-demographic characteristics of the population (Profession, Education, Age, and Marital status), attitudes and general traffic behavior (Vehicle loading volume). It

also extends into general driving nature of the population relating to driving behavior, years of driving experience.

From the analytical framework (Figure 2), I am going to analyze the different causal factors which are divided into three groups: Human (behavior) factors (socio-demographic characteristics, vehicle loading volume); vehicle factors (tyres' conditions – type of vehicle); road (environment) factors (type of road – weather conditions – visibility – days of the week) and show through the findings how they all cause road traffic accidents.

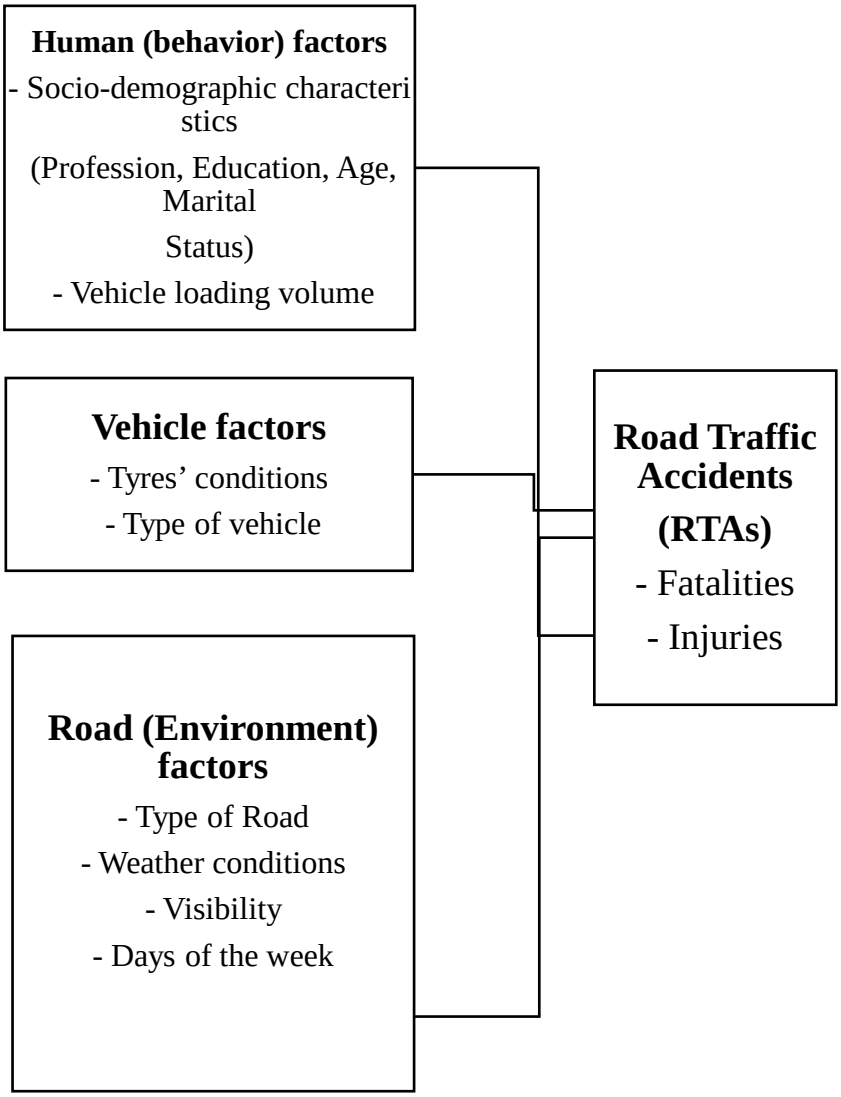

Figure 4.1 Analytical framework

Chapter 5. Analysis and Findings

The aim of the study was to analyze the trends of Road Traffic Accidents at national level and its capital city, Dakar from 2012 to 2016. The analysis entails graphs, charts and tables production to show the dynamics of the research findings, amongst which are to describe the composition of road traffic accidents' injuries and fatalities in Senegal and Dakar; and to identify road traffic injuries and fatalities hotspots within the study area, as well as to analyze the different attributes that contribute to injuries and fatalities as determined from the research data collected. The major caption in the specific objectives was used to formulate the heading wherein the data collected from the research findings were graphical presented and explanatory analyzed. Furthermore road traffic injuries and fatalities are a combined responsibility of human behavior, vehicular and environmental induced factors. The resolution of the United Nation (UN) in 2010 was to reduce world death due to road traffic accident by 50% in year 2020, hence declaring 2011-2020 as action decade for road safety. This declaration was directed at providing individual country members platform to take proper steps and action in ensuring that road traffic accidents vis-à-vis road traffic accidents (injuries and fatalities) are reduced to a minimum level so as to save more lives. The Direction of Road and Transportation and other relevant offices are

responsible to monitor and ensure that the goal of road traffic death reduction is achieved by 2020.

However, the data comprising composition of Road Traffic Accidents (injuries and fatalities) at the national level and Dakar was obtained and collected from Road Accident reports as compiled by the Department of Roads and Transport all accidents reported in all police stations within the country. This was also double checked with the traffic department office responsible. The daily road accident reports from 2012 to 2016 was used in the data presentation and analysis for this research and reported in this dissertation. The researcher was able to streamline all the information provided from the road accident reports data based even though some of them were skewed due to some missing information according to important variables on RTAs and some errors in correctly entering information in the traffic department database.

This part presents the results addressed by the first research question which was about the trends of Road Traffic Accidents (fatalities, injuries) in the capital city (Dakar) and nation average from 2012 to 2016. Analyses of register based accident data revealed the findings within the area of the first research question which was trying to describe the number of road traffic accidents'

fatalities and injuries which occurred in Senegal comparing to Dakar for the past five years (2012 -2016).

This data have been categorized into number of accidents (based on: visibility, vehicle loading volume, area, vehicles' tyres' condition, days of the week, weather condition, type of road), number of people killed or injured (drivers, passengers and pedestrians), number of vehicles involved in road traffic accidents. This part presents results of traffic accidents reported by the Direction of Road Transportation (DRT). The study used secondary data. Secondary data refers to data which is collected by someone**.** Common sources of secondary data for social science include censuses, information collected by government departments, organizational records and data that was originally collected for other research purposes.

Secondary data was collected for this study with regard to information concerning the whole country (Senegal) and the capital city (Dakar). Collected from Direction of Road Transportation and Opening up (DRT-MITTD), they were used as the source of this study to determine the pattern and trends of causal factors of road traffic Accidents included fatalities and injuries. Basic descriptive statistical analyses including simple bar, multiple bar charts and line graphs as well as trend analysis (time series) were used in the analysis. Time series (trend)

analysis involves variables whose values represent equally spaced observations of a phenomenon over time. Aggregate data was used in the analysis. Classic time series involves forecasting future values of a time series based on patterns and trends found in the history of that series.

5.1 Factors analysis

Table 5.1 Total number and rate of Road Traffic Accidents by different factors at national level, in Dakar and the other regions from 2012 to 2016

Source	Total number and rate of RTAS / Year											
	2012		2013		2014		2015		2016		Total Number of Accidents for 5 years	Average of 5 years
	case	Acc. Rate	case	Acc. Rate	case	Acc. Rate	case	Acc. Rate	case	Acc. Rate		
National	1838	31.66	1633	28.13	1330	22.90	495	8.52	510	8.79	**5806**	**1161.2**
Dakar	1123	31.14	959	26.59	749	20.76	358	9.93	418	11.58	**3607**	**721.4**
Other Regions	715	32.52	674	30.65	581	26.42	137	6.23	92	4.18	**2199**	**439.8**

Source: Direction of Road transportation (BAAC)

The trend of road traffic accidents in Senegal has been slightly in decrease for the five-year period (2012 to 2016). According to the Direction of Roads and Transportation's report, in a period of five years the percentages of RTAs was 31.66% in 2012, 28.13% in 2013, 22.90% in 2014, 8.52% in 2015 and 8.79% in 2016 at the national level with an average of 1,161.2 per year; the percentages of RTAs in Dakar were 31.14% in 21012, 26.59% in 2013, 20.76 in 2014, 9.93 in 2015, and 11.58% with an average of 721.4 per year. But for the rest of the regions of the country, the percentages of RTAs were 32.52% in 2012, 30.65% in 2013, 26.42% in 2014, 6.23% in 2015 and 4.18% in 2016 with an average of 439.8 per year. The road accidents may be attributed to factors found in the data and which will be analyzed, it will help to examine the trend.

Table 5.1 above shows the trend of RTAs in Senegal, its capital city Dakar and the others Regions from 2012 to 2016.

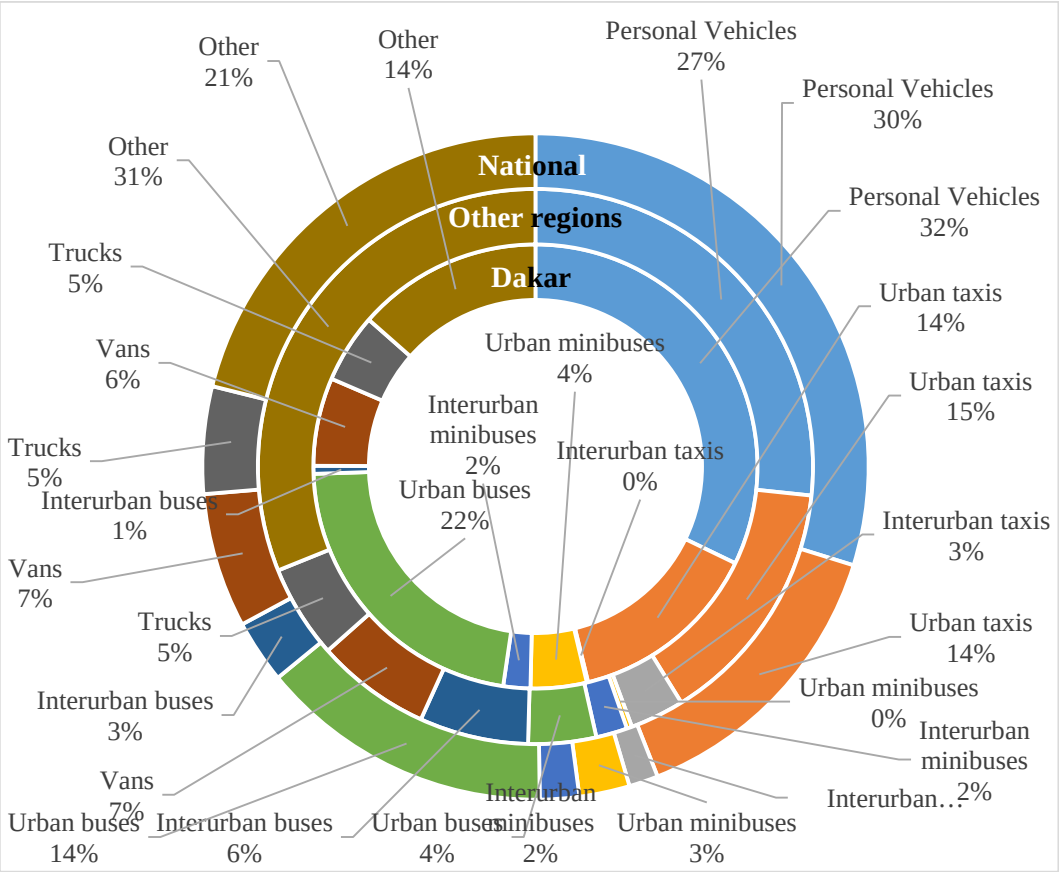

Figure 5.1 Total number of vehicle by type involved in traffic accident at national level, the other regions and Dakar (2012-2016)

Source: Direction of Road transportation (BAAC)

Looking at Figure 5.1, the trend's analysis of vehicle involved in road traffic accidents based on type at National and Dakar between 2012 to 2016 provided indications of which of the type of vehicle recorded the highest rate during the period of the study. Observation from the analysis showed that

Personal vehicles(Nat=29%, Dk=32%, other regions=27%), Urban buses (Nat=14%, Dk=21%, other regions=4%), followed by Urban Taxis (Nat=14%, Dk=13%, other regions=15%), have the highest rate of road accident at the national level and even Dakar at the period of the study, the relative reason why the rate of Personal vehicles (Private vehicles) was increasing almost every year must be explained by the fact that the authorities change the regulations on vehicle import which open the vehicle market to every middle income person and household to afford a vehicle based on income increase these last years.

The decree rising the age of vehicles allowed to import in Senegal from five to eight years old vehicles has exploded the country car fleet. As for Urban buses and Urban Taxis (Commercial Vehicles) have high rate of accident due to high speed. Most of these vehicles' drivers are too young and inexperienced; and they drive in high speed in order to fulfill the daily or monthly contract. Another finding can be explained that defective tires, poor brake systems and headlamps contributing to road accidents as a result they avoided police check points. This is consistent with previous study (Odero, 2004). The main reason for this could be that most of the vehicles are bought as used vehicles from developed countries especially France, Germany, Italy and Japan. Due to high poverty levels, the majority buy very old (used) vehicles which, according to Senegalese customs and

revenue system, attract lower import duty. The minibuses are usually bought as goods caravans but are converted into passenger vehicles by installing passenger seats locally without provisions for seat belts. In some cases more seats are squeezed so as to increase the number of passengers which exceeds the vehicle's carrying capacity. Due to high poverty levels, most people in rarely maintain their vehicles and if they do so they use cheap and substandard spares making these vehicles causal factors of road traffic accidents. As opposed to private and commercial vehicles, the industrial vehicles, are not heavily affected by road traffic accidents because most of them are very experienced and to run the risk not to be fired by their companies, they have the obligation to respect the traffic laws.

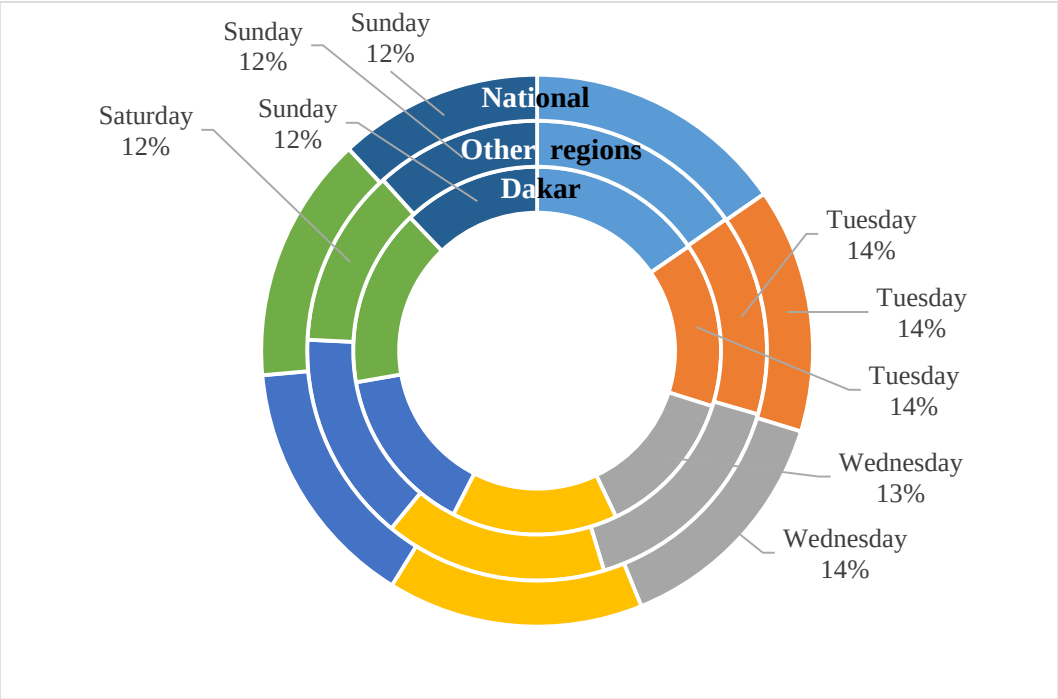

Figure 5.2 Road traffic accidents by days of the week at national level, the other regions and Dakar (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

In consideration of days of the week grouped into weekday and weekend, most of the road accidents at national level and Dakar were observed towards weekends, on Friday (Nat=15%, Dk=15%, other regions=15%) and Saturday (Nat=15%, Dk=15%, other regions=15) as shown in Figure 5.2. Together the three days of weekends (Friday, Saturday and Sunday), on the one hand, accounted for almost half of accidents (44%) at the national level and even in

Dakar. This might be attributed to less traffic volumes on roads hence drivers over speed due to reduced presence of traffic police officers on the roads. On the other hand, import number of accidents occurred during weekdays but less than weekends at the national level and in Dakar like Monday (Nat=15%, Dk=15%, other regions=15%) and Tuesday (Nat=14%, Dk=14%, 14%). The reason might be given to the heavy movement in the country because these days coincided to the fact that everybody move to run errands. Figure 5.2 reveals that there is a difference between weekdays to total road accidents and weekends to total road accidents; it means more accidents occurred during weekends that weekdays.

Accidents mostly occurred more during weekends because the country is majority Muslim (98%) and some people move inside the country, to religious cities for the Friday prayer which is really important for communities, and for Saturdays and Sundays, many of take their weekend with the envy and the hurry to resume their homes. Another interesting finding which could be explained by risk theory and congruent to previous studies (Ackaah & Adonteng, 2011; Odero et al., 1997; Valent et al., 2002) was that most incidences happened towards weekend especially on Friday and Saturday. This could be attributed to less traffic volume on the main roads on weekends making drivers over speed an element of risk compensation since during the week days there are usually congestions.

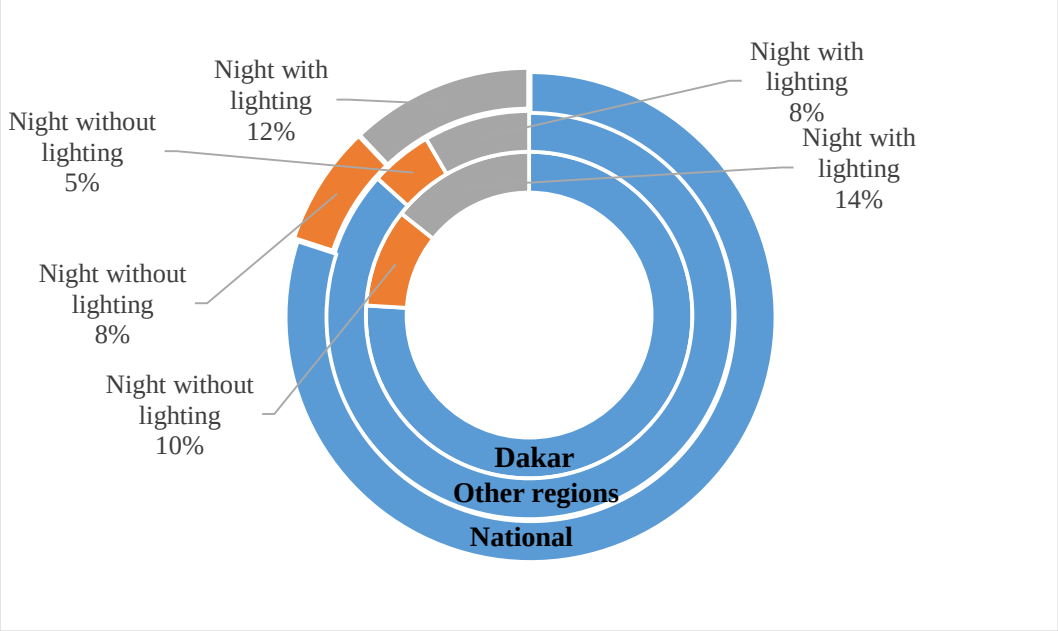

Figure 5.3 Road traffic accidents by visibility at national level, the other regions and at Dakar (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

Figure 5.3 shows the distribution of total number of accident reported by visibility. It reveals that accidents occurred mostly during daylight at national level and in Dakar (Nat=80%, Dk=76%, other regions=76%), this might be attributed to heavy traffic volumes due to economic and social activities movements of people during the day. Another reason could be the lack of enforcement coupled with reduced presence of traffic police officers on the roads. Accidents also happened secondly during night without lighting, it might be

attributed to fatigue of the drivers or technical failure (vehicle light) of the vehicle which can prevent drivers from having a good sight.

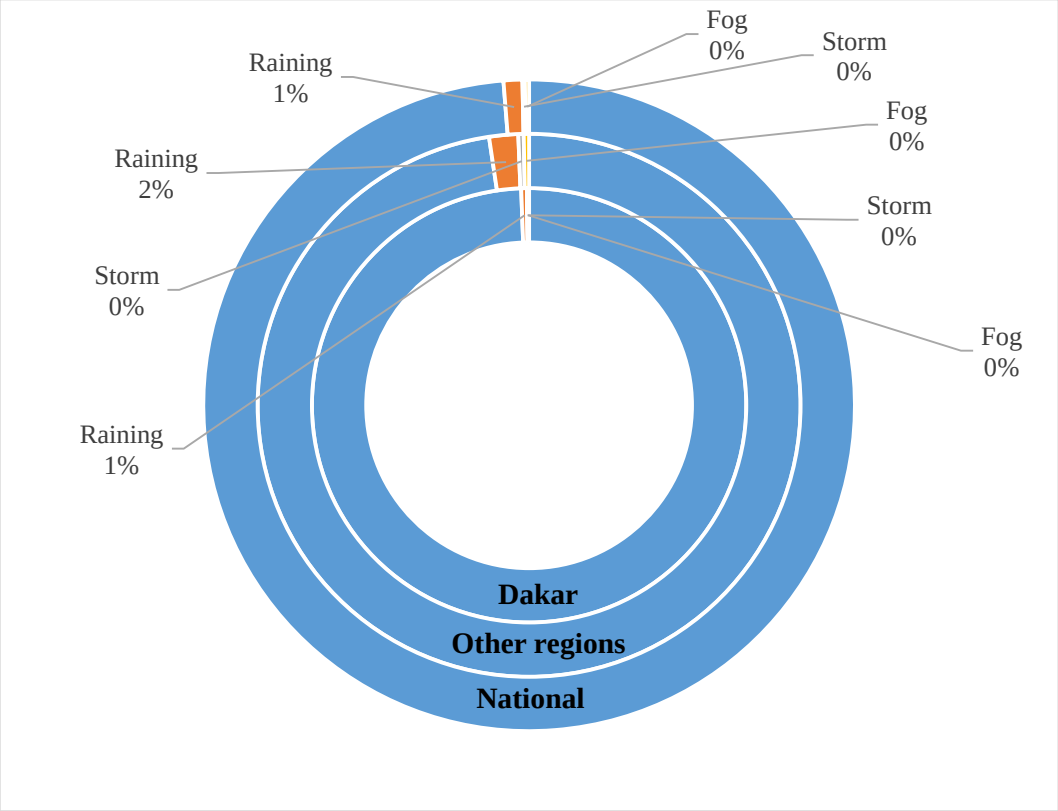

Figure 5.4 Road traffic accidents by weather conditions at national level, the other regions and Dakar (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

Considering the total number of accidents by weather conditions at national level and Dakar during the period of the study, Figure 5.4 shows that road traffic accidents occurred mostly when the weather was normal at national level,

even in Dakar (Nat=99%, Dk=99%). It might be attributed to the fact that drivers feel at ease to on road, this incites them to drive in high speed because the normal weather doesn't affect their capabilities and the vehicle performance. This also implies that the recorded observed accidents were real and did not happen by chance. So the finding reveals that the normal weather and the rain contributed to road traffic accidents more than storm and fog. Due to normal or stable weather drivers feel at ease to on road, this incites them to drive in high speed because the normal weather doesn't affect their capabilities and the vehicle performance.

It is also observed in figure 6 that the rainfall affects road accidents. It generally acts through visibility impairments, precipitation and high winds to affect driver capabilities, vehicle performance (i.e., traction, stability and maneuverability), pavement friction, and roadway infrastructure. Several studies have been conducted on weather conditions and road traffic accidents during rainfall. (Lamm, et al 1990)

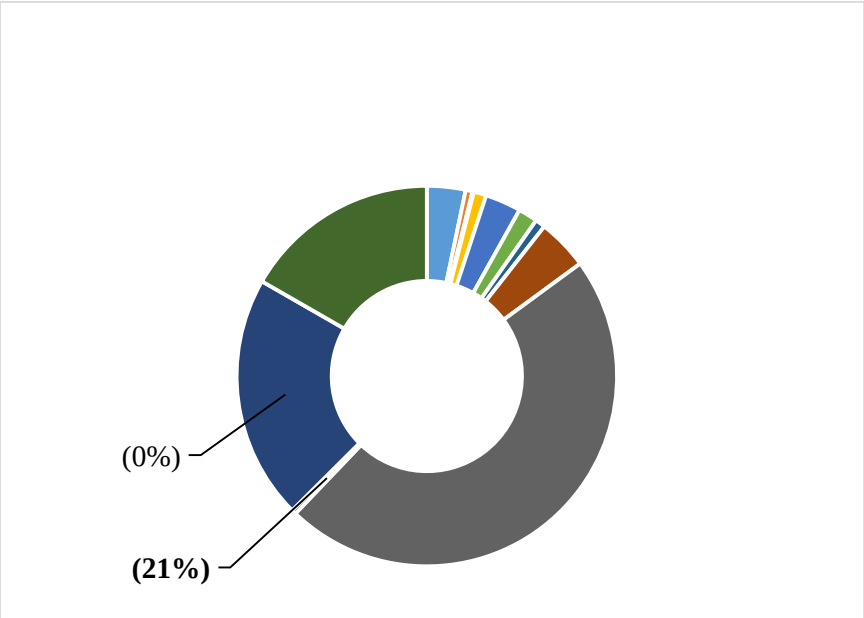

Figure 5.5 Drivers involved in road traffic accidents by profession at National level (2012-2016).

Source: Direction of Road transportation (BAAC- 2016)

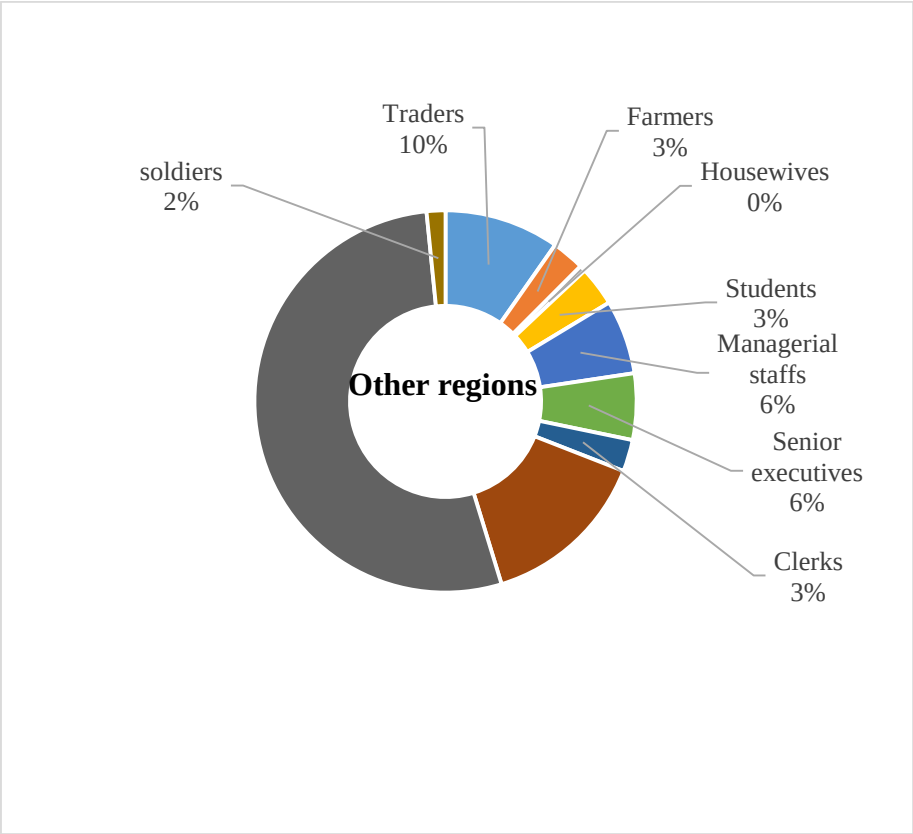

Figure 5.6 Drivers involved in road traffic accidents by profession in the other regions (2012-2016)

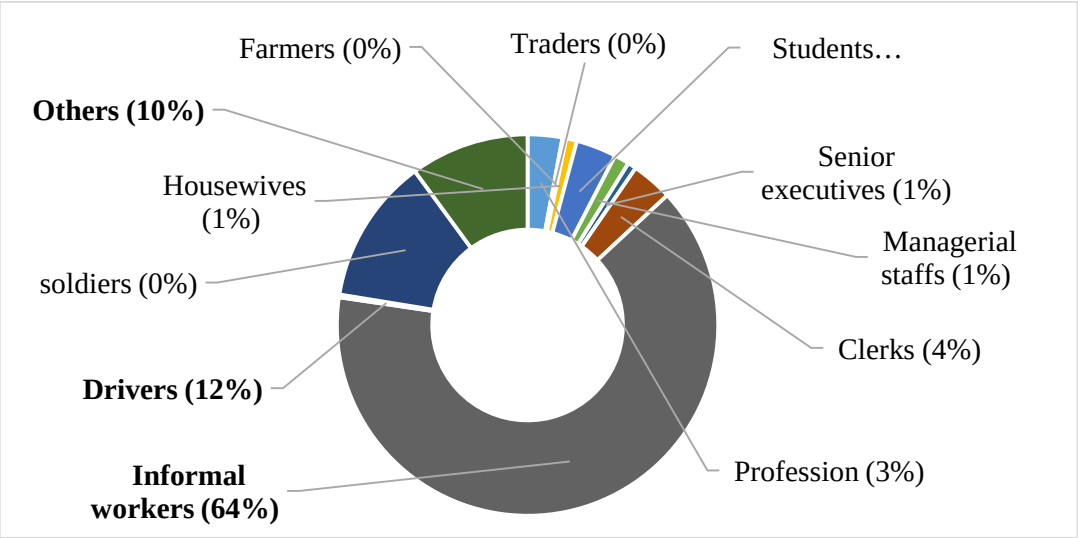

Figure 5.7 Drivers involved in road traffic accidents by profession in Dakar (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

In consideration of Drivers' Profession, most of the road accidents at national level, other regions and Dakar were observed towards informal workers (Nat=47%, Dk=64%, other reg=14%), drivers (Nat=21%, Dk=12%, other region=54%) and others (Nat=17%, Dk=10%, other regions=14%) as shown in figure 5.7. It would be explained by the fact that many informal workers, drivers and others get their driving licenses very easily from driving schools (by corruption). The figures show that drivers and some others are more significantly involved in road accidents than other professions like clerks, farmers managerial

staffs etc.… The significant differences observed were real as recorded in accident report because for drivers, they neither respect the traffics laws nor master the driving skills, and they generally drive with reckless with bad behavior and attitude and they are only interested in delivering quickly their passengers or their goods in order to earn money and fulfill the contract that links them with car owners. So according to (Horwood and Fergusson 2000) driving without skills to be one of a constellation of risky driving behaviors that may include speeding, unsafe and careless driving and also found that the high rates of accidents reflect a general tendency to risky driving As opposed to professional drivers, the other drivers are not heavily affected by road traffic accidents because most of them master and respect the traffic laws.

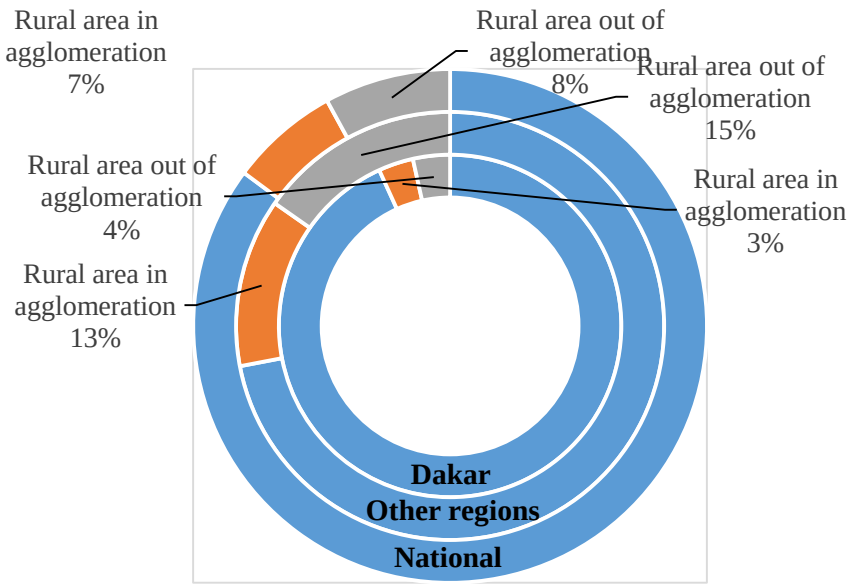

Figure 5.8 Road traffic accidents by areas at national level and Dakar (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

Figure 5.8 depicts an important occurrence of road traffic accidents in urban areas at the national level and in Dakar (Nat=85%, Dk=93%, other reg=72%), followed by rural areas in agglomeration with 7% at national level and rural out agglomeration 8% also at national level. It might be attributed to the density and business of urban areas. Urban areas are the meeting point of people for their economic and social activities, and there are more vehicles in urban areas

than the others. The figure reveals that accidents occur more in rural area in agglomeration and rural area out of agglomeration than urban area.

This fact is explained by the fact that in rural area in agglomeration and out of agglomeration there is no road congestion and drivers speed up to compensate the time lost due to police check up as sustained by previous studies (Assum et al 1999). It may be related to lack sidewalks, footbridge for pedestrians. Opposed to rural areas in agglomeration and out of agglomeration, the study revealed that less accidents occurrence in the urban which are densely populated in terms of humans and vehicles

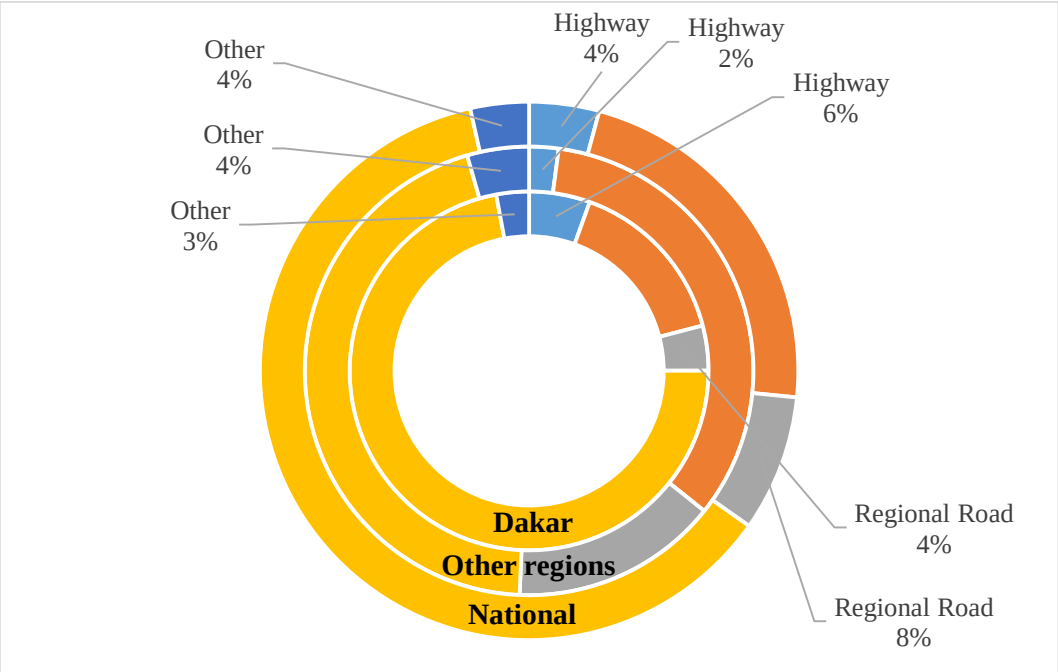

Figure 5.9 Road traffic accidents by type of road at national level and Dakar (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

In consideration of roads grouped into urban roads, national roads, regional roads, highway and other roads, most of the road accidents at national level, in other regions and in Dakar were observed towards, on urban roads (Nat=62%, Dk=74%, other reg=45%) and on national roads (Nat=22%, Dk=15%, other reg=34%) as shown in Figure 5.9. Together the two type of roads (urban

roads and national roads), on the one hand, accounted for almost more than half of accidents (62%) at the national level and 22% in Dakar.

This might be attributed to less traffic volumes on national roads hence drivers over speed due to reduced presence of traffic police officers on the roads at national level and in Dakar. On the other hand, important number of accidents occurred on urban roads because of the density of the urban areas with vehicles and economic, social activities of people. The figure reveals accidents occurred more in other roads, highways than national, regional and urban roads. However, drivers speed up in highways without respecting the laws, and the highways are not well managed, that lack of management allows animals (cows, sheep……) cross at any time unexpectedly, so in front of this situation, drivers always lose the control of their vehicles. Findings have been sustained by previous studies (Muhlrad & Lassarre, 2005).

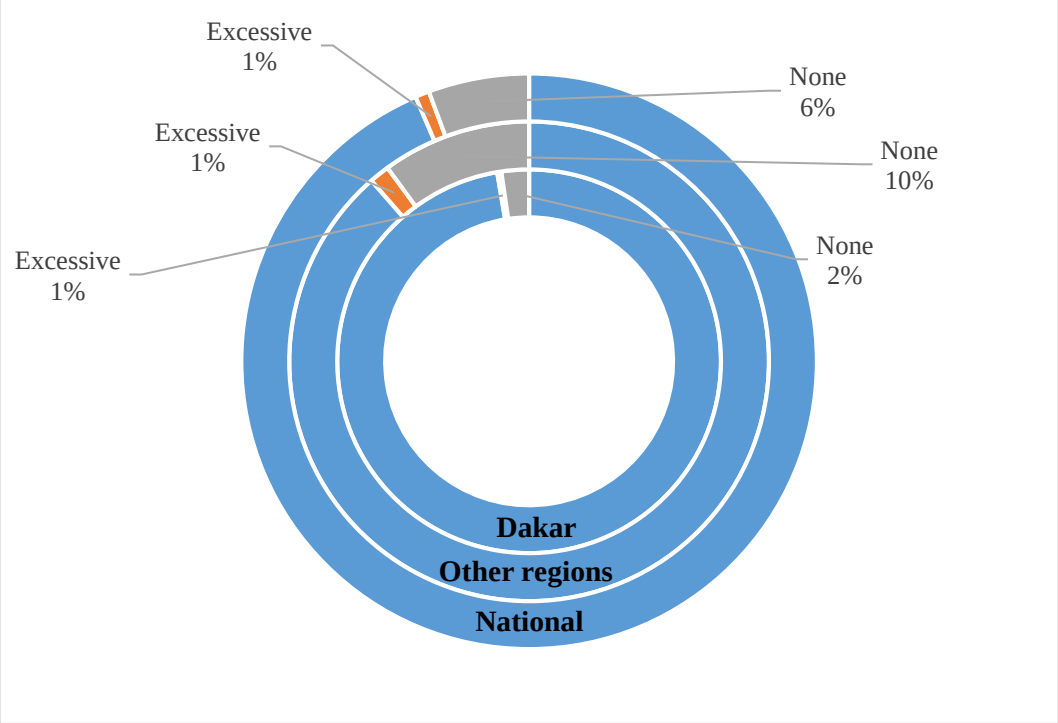

Figure 5.10 Road traffic accidents by vehicle loading volume at National level and Dakar (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

Considering the total number of accidents by vehicle loading volume at national level and Dakar during the period of the study, Figure 5.10 shows that road traffic accidents occurred mostly when the loading volume of the vehicle is normal with 97% in Dakar and 93% at national level and 89%. It might be attributed to the fact that drivers feel at ease to on road, this incites them to drive

in high speed because the normal loading volume doesn't affect their capabilities and the vehicle performance.

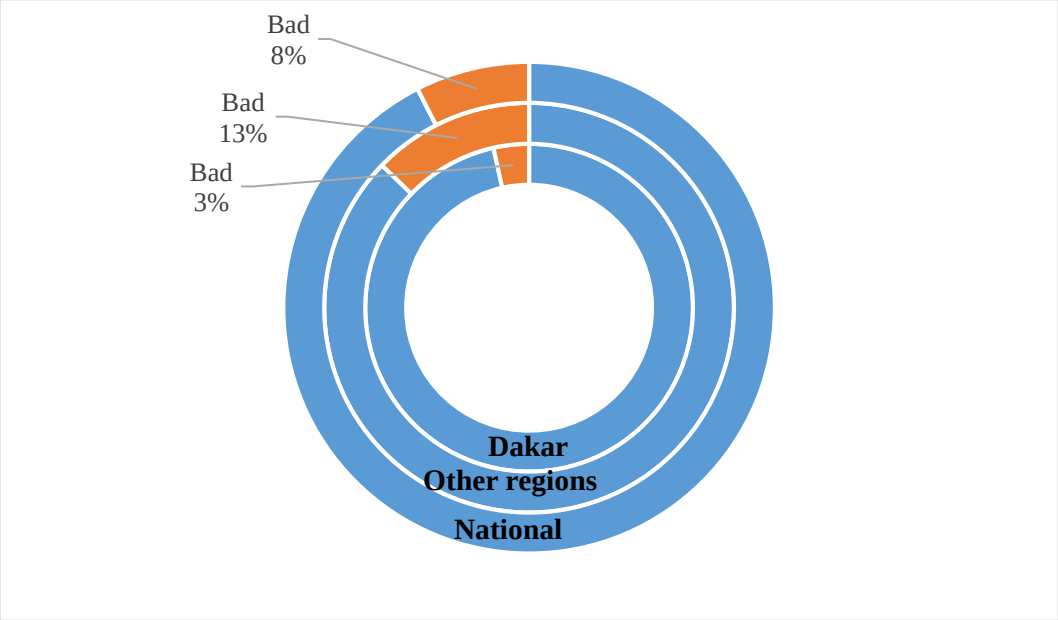

Figure 5.11 Road traffic accidents by tyres' conditions at national level and Dakar (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

Figure 5.11 shows the distribution of total number of accident reported by tyres' conditions at the national level, in the other regions and in Dakar. It reveals that accidents occurred mostly when vehicles' tyres are in good condition with 92% at the national level, 87% in the other regions and 97% at Dakar. It is observed

that there were more accidents with good tyre's conditions in Dakar than the national level and the others region, this might be attributed to the fact that drivers feel at ease to drive a vehicles which have good tyres, and this incites them to drive in high speed because good tyres don't affect their capabilities and the vehicle performance. Few accidents happened during the period of the study due to may be fear of drivers to speed up with their vehicle's tyres' conditions.

5.2 Comparative analysis between national level, the other regions and Dakar, statistical analysis and implications

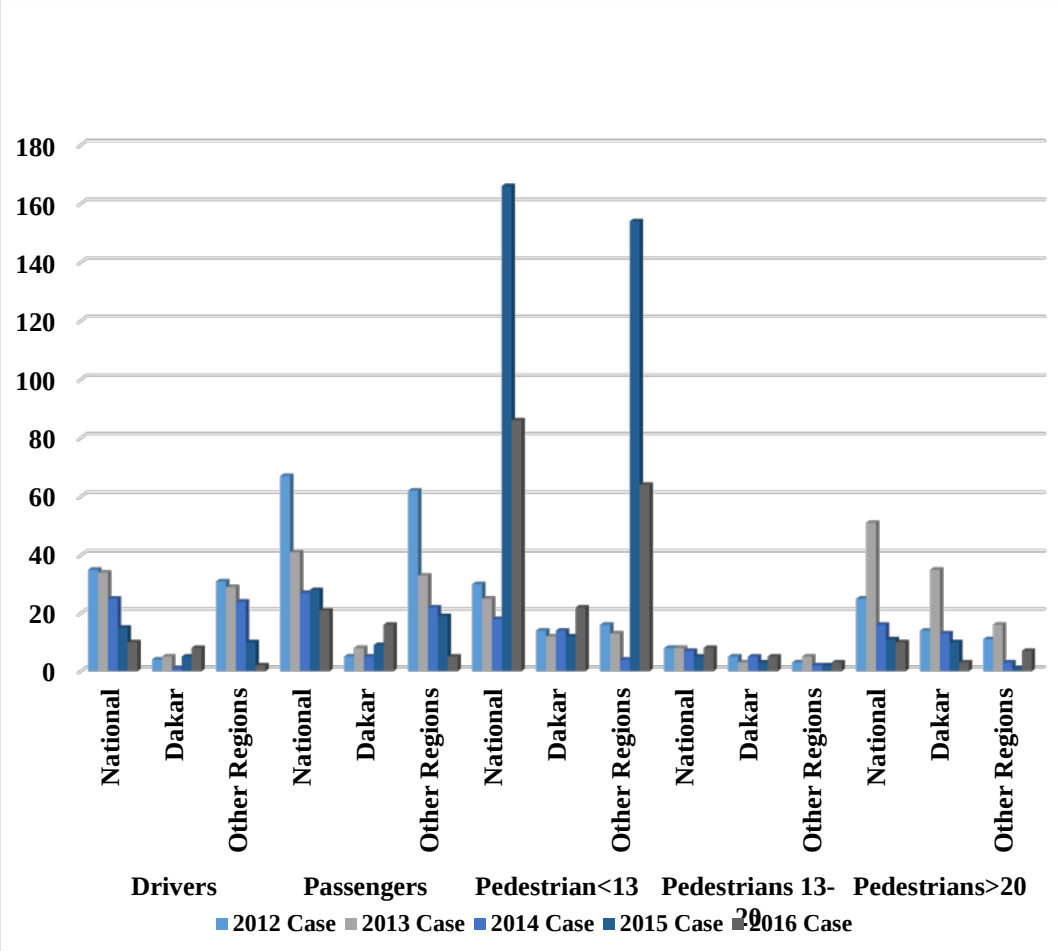

Figure 5.12 Road Traffic Fatalities by group of road users in National level, Dakar and other regions (2012-2016)

Source: Direction of Road transportation (BAAC- 2016)

The analysis of road traffic fatalities by group of road users at national level, in Dakar and other regions show that there were more fatalities at the

national than Dakar. Figure 5.12 also shows that the pedestrians under 13, the pedestrians above 20 and the passengers group were the most affected, followed by driver and pedestrians between 13 and 20. The figure depicts that, the years 2015 and 2016 recorded the highest number of fatalities and the upward was on pedestrians under 13, followed by pedestrians above 20. The analysis of fatalities reflects the downward in 2012, 2013 and 2015. We can notice that pedestrians (Children and adults) at the national level are the most vulnerable and the most important number of fatalities and injuries during the period of the research among the group of road users.

However, most of the pedestrians under 13 (children) are primary students and they ignore the road regulations or traffic laws (they don't know how to cross road), in addition to that, we notice that primary schools' location is too close to the roads, to make them accessible to everyone but this constitute a very big danger to children who always unconsciously and personally try to cross the roads. Even at the national level, Figure 5.12 revealed also that adults suffer a lot from fatal accidents because of the ignorance of the traffic laws. For pedestrians over 20 fatal accidents occur mostly when they cross or walk alongside the road without signs for pedestrians. As for some researchers younger children (between 6 and 13) are at highest risk of fatality, with an estimated minimum four times the

risk of accident compared with adult pedestrians also suffer a lot from fatal accidents.

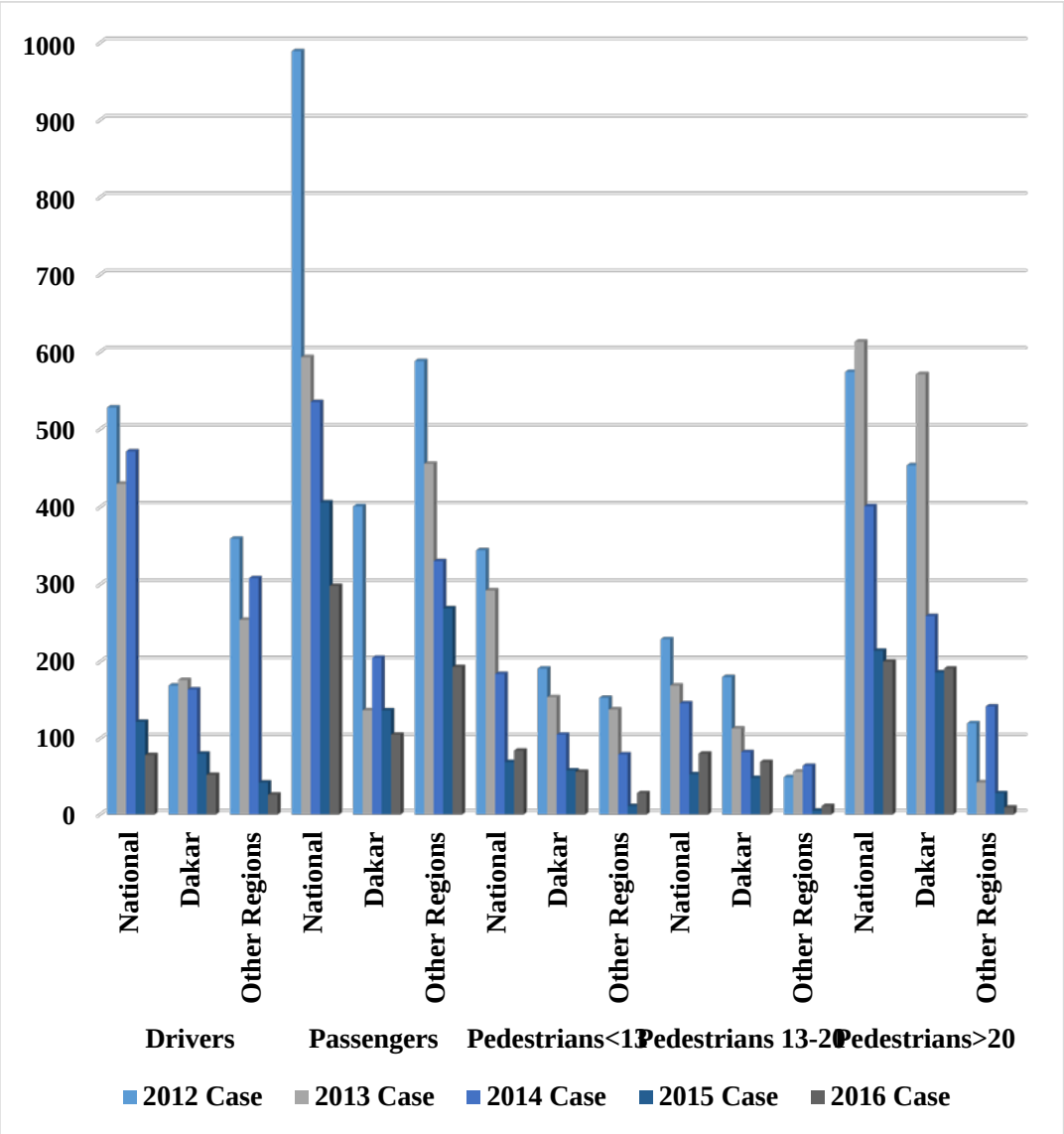

Figure 5.13 Road Traffic Injuries by group of road users in National level, Dakar and other regions (2012-2016)

The analysis road traffic injuries at national level, in Dakar and the other regions of the countries shows that there were more injuries at the national level than in Dakar. Figure 5.13 also shows the passengers, the pedestrians above 20 and the pedestrians under 13 groups were the most affected, followed by driver and pedestrians between 13 and 20. Nevertheless comparing with the national level, the situation of the capital city (Dakar) in terms of fatalities and injuries of group of road users is less heavy, but still pedestrian under 13 (children) and pedestrians over 20 (adults) suffer more than the other road users as shown in the Figure with almost the same causes than the national level, with the difference that the business of the capital city where there are lots of movements (Markets….).

But as for pedestrian under 13, they are exposed to fatal accidents as they cross roads within residential areas or in the city center. Their vulnerability is worsened by lack of traffic separation (sidewalks), zebra crossing, pedestrians' bridges, and tunnel in road design.

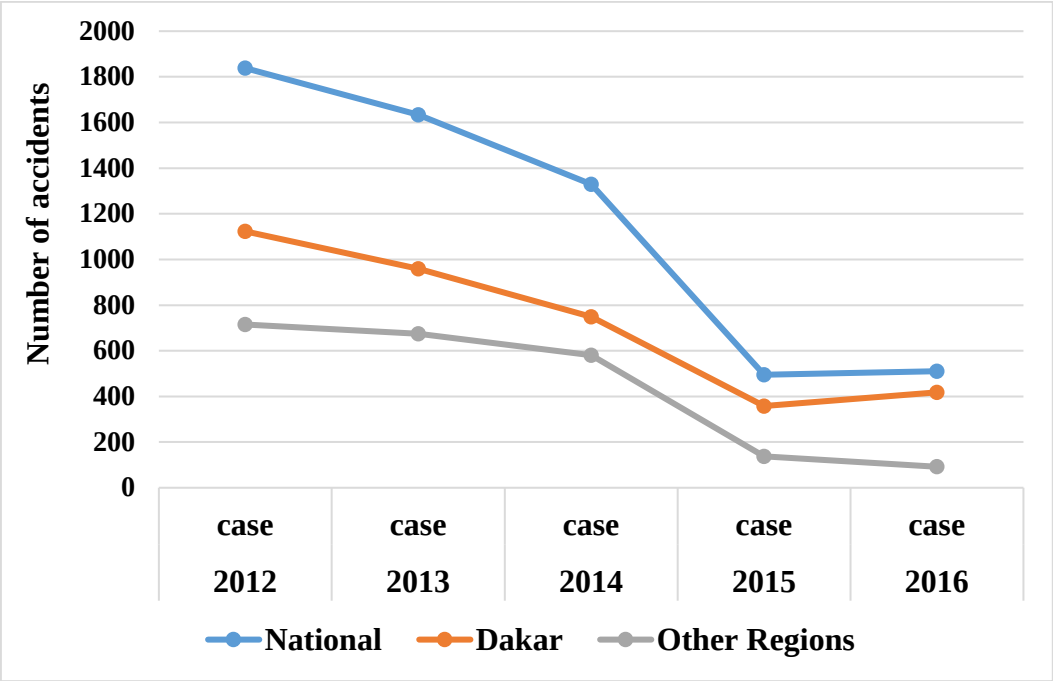

Figure 5.14 Trend of road traffic accidents at National level, Dakar and others regions (2012–2016).

Source: Direction of Road transportation (BAAC- 2016)

The trends of Road Traffic accidents at National level, Dakar and the other regions from 2012 to 2016 were shown in Figure 5.14. Firstly, there has been a substantial decrease in accidents at the National level and Dakar as well from 2012 to 2015. This can be explained the fact of establishing a “Five year plan of the new presidential regime’s government” to reduce the road traffic accidents by taking lots of measures, including the implementation of speed bumps at the out-

agglomeration hotspots, the multiplication of junctions, interchanges and overpasses at certain urban axes, prevention and awareness campaigns, the upcoming implementation of the (*"Permis a point"),* "fact of reducing some points on your license and the transportation authorities began implementing the President of the Republic's concept which is based on *"zero tolerance"* means no tolerance on breaking the road regulations and laws that make the accidents reduce a lot from 2012 to 2015. However we notice a stagnancy of fatalities from 2015 to 2016 because to fight against insecurity, the road safety authorities took the decision to remove all speed bumps at the out-agglomeration hotspots because many road users claimed being assaulted by armed groups at these speed reducers, so the trend of accidents was constantly stable from 2015 to 2016 at the national level, in Dakar and in the other regions as well.

Table 5.2 Victims of traffic accidents by road users group in Senegal from 2012 to 2016

Source	Group	Fatality		Injury	
		Ave. cases per year	Rate (per 10,000)	Ave. cases per year	Rate (per 10,000)
National	Drivers	23.8	.0154[ab]	326	.2103[abc]
	Passengers	36.8	.0237[ab]	564.2	.3640[a]
	Pedestrians<13	65	.0419[a]	194.6	.1256[bc]
	Pedestrians 13-20	7.2	.0046[c]	135.4	.8736[c]
	Pedestrians>20	22.6	.0145[ab]	400.4	.2583[ab]
	P Value		.074*		.012**
Dakar	Drivers	4.6	.0144[b]	128.2	.4006[b]
	Passengers	8.6	.0269[ab]	197	.6156[ab]
	Pedestrians<13	14.8	.0463[a]	112.8	.3525[b]
	Pedestrians 13-20	4.6	.01438a[b]	98.4	.3075[b]
	Pedestrians>20	15	.0469[a]	332.2	1.0381[a]
	P Value		.025**		.011**

*, ** Means α<.1 and α<.05 respectively.

Looking at the one-way ANOVA (Table 5.2) for road traffic fatality and injuries for the 5 years studied period at national level, it was observed that variation among the road users was statistically significant at (p=.074) for fatalities and was statistically significant at (p=.012) for injuries, and in Dakar it

also observed that variation among the road users was statistically significant at *(p*=.025*)* for fatalities and was statistically significant at (*p*=.011). This also implies that the recorded observed fatalities and injuries were real and did not happen by chance. So an interesting finding was that pedestrians under 13, above 20 and passengers were the most vulnerable road users. The pedestrians and passengers' number of fatalities and injuries together is really important which is in support with findings from previous studies (Afukaar et al., 2003; Chen, 2010; Lagarde, 2007; Mabunda et al, 2008; Nantulya & Reich, 2002; Odero et al., 1997). One possible explanation for high pedestrians involvement at the national and in Dakar could be that majority of the people do not drive but walk along and cross roads in the rural and urban areas which could lead to higher exposure to traffic accidents. The other possible explanation could be attributed to behaviors of both drivers, passengers and pedestrians who violate traffic regulations with regard to crossing roads and speeding in densely populated areas. Another reason is that road infrastructure in Senegal (urban and rural) has low level of traffic separation (motorized vs. non-motorized). The reason for passengers' involvement could be due to the fact that the majority of the people use public buses which are usually overloaded and have no safety devices such as seat belts and airbags.

5.3 Findings

The current study was aimed to analyze the trends and examine the causal factors of RTAs in Senegal from 2012 to 2016. The findings show that there a slight reduction of trends some of the factors contributed to RTAs occurrence resulted to fatalities and injuries of road users group. Through the results findings, the communities' well-being can be improved through road traffic policy. But the challenges that authorities may face while implementing their activities are as follows: corruption, weak enforcement, lack of participation, mindset changes, absence of staff training etc.…Although Senegal has adopted the resolution of the United Nation (UN) in 2010 to reduce world death due to road traffic accident by 50% in year 2020, hence declaring 2011-2020 as action decade for road safety, it is not yet close to achieving its objectives since it is still ranked among the poorest, most corrupted nations. This may have a negative effect on its road traffic management and economic growth. The RTAs situation, which is the main variable to look at, displayed a negative sign which shows the lagging behind of road safety in Senegal has affected the movements of people in the region. Road traffic safety policy in Senegal aim at making communities be safe and travel in

good conditions. Odero (1997) suggested that road safety effects from traffic management depended on road safety policy.

Chapter 6. Conclusion

6.1 Summary

The available road accident data reports from 2012 to 2016 as documented by the Direction of Roads and Transportation (DRT-MTTD) have been used to analyze trends and to examine the causal factors associated to the trends of road traffic accidents (injuries and fatalities) at National level and in Dakar, which were the objectives of this study. The findings of the road accident reports were analyzed and presented using both statistical and geographical information system techniques in producing graphs, tables and charts. An analysis of the results revealed the followings:

The first conclusion is that road traffic crashes are caused by different multiple factors which include technical factors such as level of development of road infrastructure, general vehicle conditions and availability of public transport which is an attribute of the traffic system. In addition there are also institutional and behavioral factors like traffic rule enforcement and driver training and licensing system and road users' attitude and behavior. In this study, causal factors of road traffic accidents have been identified into the following categories:

- **Human (behavior) factors** (Socio-demographic characteristics: Profession, Education, Age, Marital Status; vehicle loading volume); - **Vehicle factors** (tyres' conditions, type of vehicle); - **Road (Environment) factors** (type of road, visibility, weather conditions, days of the week).

The composition of road traffic injuries and fatalities since the commencement of action decade for road safety in 2011 shows a reduction in the number of accidents and casualties recorded at the national level and a slight increase in Dakar. There was significant values ($\alpha<.05$ and $\alpha<.1$) among all the group of road users studied. The differences observed were real and did not occur by chance for the five-year period (2012-2016). There has been a down trends movement in road traffic fatalities at the national level and in Dakar and a slight increase in Dakar in road traffic injuries recorded for the study period. Among the road users' group, the pedestrians under thirteen (children), over 20 (adults) and passengers suffered more from road traffic fatalities and injuries in the five-year-study period within the national level and Dakar. There was an 18% fatalities reduction at national, -28% increases in Dakar and 72.22% injuries reduction at national, 66.1% reduction in Dakar from 2012 to 2016.

Over all the findings of this study confirm that There has been a down trends movement in road traffic accidents at the national level and a slight increase in Dakar in road traffic injuries recorded for the study period, among the

road users' group, the pedestrians under thirteen (children), over 20 (adults) and passengers suffered more from road traffic fatalities and injuries and multiple factors and that in trying to address them, a multifaceted approach should be taken.

6.2 Policy Recommendations

From the data analysis and findings of this research, the following policy recommendations are made to ensure road traffic accidents are reduced by not just 50% but 70% or more by 2020:

There should be proper collation of road accident report for both fatalities and injuries from all relevant sources, departments and systems in a standardized format, quality and definitions should be compatible and user-friendly to all. There should be web-based GIS hotspots for the whole country which will be updated every year to keep abreast with locations that might miss. This will assist traffic officials when they want to deploy their personnel for patrol duties.

There is need for in-depth study and research on each of the identified contributing factor associated with road traffic accidents injuries and fatalities to provide in-depth information which can be used to revise the present road traffic

policies, intervention campaign programs aimed at reducing road injuries and fatalities.

Road awareness campaigns should be carried out every month end to keep reminding all road users of the essence of road safety measures. Also there is need to adhere and comply with the regulations and road signage. There is a great need for more road safety awareness campaign to enlighten and educate the vast majority of pedestrians within the country. There should be a curriculum on road safety to be taken at school and part of driving lessons before issuance of driver license.

The Direction of Roads and Transportation (DRT) should recruit and train more traffic officers to ensure an even distribution of traffic officials on all roads not only during peak traffic period but at all times. Strict enforcement should be given to vehicles that exceed the normal loading volume and. All traffic offenders in the country should be prosecuted by the law.

There is a need to consider Intelligent Transport System (ITS) vehicles which will be produced with low speeds and engine capacity. Only emergency vehicle which will be stationed at all visible streets will be of high speeds and high engine capacity. The funds paid through Road Accident Fund (RAF) should

be used to develop and subsidize intelligent vehicle which can detect potential road hazards 500 meters ahead and will make the driver pull over automatically.

Mixed usage of road walkway and side – walk should not be allowed, as this always creates problems for right of way between motorists and pedestrians. Pedestrian bridges should be constructed in such a way that this will cater for all people and the passage should be kept clean and monitored by security personnel to ensure that it will not be used as hideouts by thugs.

All traffic departments should ensure that cars older than 15 years should regularly undergo road worthiness tests before renewing their vehicle license. The practice of car sharing and carpooling should be promoted by government and overloading and non-roadworthy vehicles should be stamped out.

The construction of new roads especially highways must consider traffic separation to harmonize all road users and facilitate traffic safety.

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Abstract in Korean

세네갈 내의 교통 사고 분석:

2012 년부터 2016 년사이의 추세와 원인

연세대학교 정경·창업대학원

지역개발 역량강화 석사학위과정

Mamadou Doudou CISS

도로 교통사고는 질병률과 사망률의 주요 원인들 중 하나이다. 2020 년까지 세계 질병 부담의 세 번째 주요 원인이 될 것으로 예상된다 (WHO, 증거, 정보 및 정책 보고서 2000) 현 상황은 차량과 인구 모두의 밀도가 높다고 묘사되어지는 아프리카 나라들에서 더 심각하게 나타난다. 본 연구의 목적은 국가적 차원에서 2012 년부터 2016 까지의 도로 교통사고와 다카르 (세네갈의 수도) 를 분석하여, 도로 교통 사고와 관련된 인과적 요소들을 조사하고 도로 교통

사고들을 야기하는 요인들을 줄이는데 있다. 세네갈에서 도로교통부가 직면하는 주된 문제들 중 하나가 바로 도로 교통사고이다.

이 연구는 다카르 (Dakar) 와 캐피털 시티의 RTAs 분석을 국가적 수준으로 확립했다. 사망자와 부상으로 이어지는 도로 교통 사고들의 직접적인 원인에 대해서도 조사했다. 또한 본 연구는 세계 보건 기구의 2011-2020 도로 안전 조치가 개시 된 이후, 세네갈에서 5 년동안 도로 교통 발생률이 감소했는지를 조사하였다. 대부분의 사고는 인간의 행동, 차량 및 도로 (환경)의 변화의 결과로 발생한다는 것이 밝혀졌다. 도로 이용자들 중 13 세 이하의 보행자는 20 세 이상의 승객과 보행자에 의해 가장 큰 피해를 입는다. 도로 안전에 대한 조치가 개신된 이래, 도로 사고가 감소한 것으로 밝혀졌다. 2011 년 이후 도로 교통 재해 및 사망자의 구성은 기록 된 희생자 수의 감소를 보여준다. 대역되었던 모든 범주의 도로 사용자들 중 높은 가치 ($\alpha<.05$) 가 존재하였다. ($\alpha<.1$) 관찰 된 차이들은 실제적이였고 우연적으로 지난 5 년간 발생하지 않았다.

핵심 단어: 도로 사고; 사망자; 부상; 도로 교통; 사상자; 동향; 대중 교통; 위험 보상; 도로 사용자 (보행자, 승객, 운전자)