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School of Transportation Sciences

Master of Transportation Sciences

Master's thesis

Understanding Fatigue as a Cause of Work-Related Traffic Crashes Among Professional Drivers in East Africa

Linda Nekesa Masibo

Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences, specialization Traffic Safety

SUPERVISOR :
Prof. dr. Kris BRIJS

CO-SUPERVISOR :
dr. Veerle ROSS

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PREFACE

Death and misery associated with road traffic crashes is a great problem all over the world. The burden of which is felt most greatly in LMIC and more so in Africa. As a road safety advocate, I have worked to advance this conversation with decision makers and do so in my work as well. Studies on professional drivers as a research group have, particularly in East Africa, been limited. Given the work conditions faced by professional drivers and the prevalence of fatigue this research topic is significant for study. This study looked at fatigue as a cause of work-related traffic crashes among professional drivers operating in East Africa. Data on the topic was collected by use of an online questionnaire on Qualtrics.

This masters this would not be possible without the support of the Flemish Inter-University Council (Vlaamse Interuniversitaire Raad/ VLIR-UOS) who awarded me a scholarship to pursue my masters' studies. I greatly appreciate their support and facilitation for my studies. I would also like to thank my supervisors Prof. dr Kris Brijs and Dr Veerle Ross for their guidance, encouragement and support developing and writing this master thesis.

I would also like to thank the people, organizations and fleet managers who shared the link to the questionnaire and the professional drivers who filled it out. I would like to especially thank Pierre Prod'homme, Health, Safety and Environment department, Total Energies and Ousséni Ouedraogo, Africa Health, Safety and Environment Coordinator, Total Energies, for sending the survey to East Africa affiliates and the affiliates for filling out the questionnaire. This master's thesis would not have been possible without all their contributions and their efforts are greatly appreciated.

Finally, I want to thank my family. My mother Margaret Masibo and sisters Maryanne Naliaka and Caroline Nafula for their encouragement and support throughout my studies.

This master's thesis was written during the COVID-19 crisis in 2021. The global health crisis had an impact on the (writing) process, the research activities and the research results that are the basis of this thesis. This is because the travel to the study location to conduct data collection in person was not possible. The research area was redefined several times out of concern that adequate data could not be collected remotely. Originally the study area was Kenya, which was expanded to Sub-Saharan Africa and finally was defined as East Africa. The target population was also redefined due to the same concern from fleet drivers to professional drivers.

SUMMARY
Every year an estimated 1.35 million people die on the world's roads and a further 50 million are injured. Traffic crashes are the 8th leading cause of death world-wide and the number one leading cause of death for children and young people aged between 5 and 29 years old. Low-and-middle-income countries face a disproportionate burden of traffic crashes with rates of 26.6 deaths per 100,000 population in Africa. The highest of any region (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019). Road crashes are caused by many factors. The factor of interest in this study is fatigue.

Fatigue is a well-known and yet puzzling concept. Generally, most people know what it feels like to experience fatigue but an exact definition has proven elusive (Matthews et al., 2012). It is understood to be a state that proceeds from a period of either mental or physical exertion and is characterised by decreased efficiency and capacity to appropriately respond to stimuli (Frone & Tidwell, 2015). Fatigue is a challenging concept because it cannot be directly observed nor objectively measured (Daeson et al., 2021). Fatigue can be categorised as either being acute or chronic. Fatigue can also be categorised according to it's causal factors as either sleep-related (SR) or active and passive task-related (TR) (May & Baldwin, 2009).

This study seeks to understand how fatigue affects professional drivers. Professional drivers work long and irregular hours, face minimal social contact, and increased health risks (Taylor and Dorn, 2006; Matthew et al., 2012). The occupational characteristics of professional drivers lead to experiencing fatigue and its deleterious effects on performance (Williamson et al., 2011). Fatigue negatively impacts driving performance through slower reaction times, reducing the ability to keep distance from adjacent cars, increase mental withdrawal from the task of driving and reduced steering performance (Ogunleye-Adetona & Felix, 2016).

Fatigue is estimated to cause about 15% to 20% of commercial vehicle fatalities (Mohamad et al., 2012). International estimated indicate that fatigue is estimated to cause about 20% of all traffic crashes. The true number is difficult to determine as drivers may be unwilling to disclose fatigue as the cause of traffic crashes for insurance or legal reasons (Matthews et al., 2012). Professional drivers spend more time on the road that the average driver and thus faced increased exposure to traffic crashes (Rune et al., 2005; Matthews et al., 2012).

To understand the impact of fatigue on professional drivers operating in East Africa a questionnaire was developed to gain insights on their driving behaviour, experiences with fatigue and its effects and whether they had experienced traffic crashes. A sample of 546 responses were reviewed and after 400 were used for analysis. Results obtained from the survey show that 91% of respondents indicated that fatigue was between a major and moderate problem in their industry. Respondents (83%) reported working between 5 and 7 days with 54% of respondents working more than 12 hours. Respondents (58%) reported experiencing issues related to fatigue such as difficulty concentrating, staying alert, and sustaining attention. Majority of respondents (76%) indicated that they did not experience a traffic crash in the preceding 12 months.

Coping measures for fatigue reported were stopping to rest, adjusting ventilation, having a drink containing caffeine, listening to the radio among others. Binary logistic regression analysis of predictor variables like age, gender, years working as a driver, number of days worked, description of work schedule and frequency of experiencing fatigue showed that frequency of experiencing fatigue was a significant predictor of self-reports of traffic crashes. Chi-square tests indicated that working against driver regulations and hours worked a day had significant effects on self-reports of experiencing traffic crashes.

Increased involvement of private sector in public transport operations and logistics, infrastructural interventions to improve road conditions, improvement of organizational safety culture and development of traffic crash checklist of information to be collected by organizations about traffic crashes are measures recommended to address the fatigue among professional drivers. Future research can investigate the impact of medical conditions, additional demographic factors not considered for this study as well as apply a behavioural intervention framework in the design of interventions.

Key Words: East Africa, Fatigue, Traffic crash, Occupational health, and safety,

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LIST OF ABBREVIATIONS

BAC	Blood Alcohol Content
EAC	East African Community
LMIC	Low- and Middle-Income Countries
WHO	World Health Organization
OR	Odds Ratio
PSV	Public Service Vehicle
TNC	Transport Network Company

1. INTRODUCTION

This master thesis investigates how fatigue affects professional drivers across selected sectors in East Africa. It looks at fatigue from the perspective of a cause of work-related traffic crashes.

1.1. Background

An estimated 1.35 million people die, and 50 million people are injured globally every year because of road crashes. Majority (93%) of road crashes occur in Low-Middle Income Countries (LMIC) (Turner et al., 2020). Professional drivers account for a significant proportion of road crash statistics which results in substantial human and financial loss (Taylor & Dorn, 2006). Road Crashes are estimated to cost as much as 9% of GDP or 128 billion in Africa (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019). To tackle this issue, in March 2010 the United Nations General Assembly proclaimed 2011-2020 the Decade of Action for Road Safety. This initiative sought to save lives and livelihoods lost through road crashes by improving vehicle standards, building road safety management capacity, improving road infrastructure, enhancing post-crash care and improving road user behaviour (*Global Plan for the Decade of Action for Road Safety 2011-2020*, n.d.)

Death and serious injury resulting from road crashes is a great burden to those affected and to society as a whole. The available statistics on road crash fatalities and injuries are only estimates. The true toll is unknown as many road crashes are not accounted for official numbers particularly in LMIC (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019). The rapid increase of motor vehicle numbers in many LMIC has seen an increase in sever traffic-related fatalities. (Zhang et al., 2016). There are three basic factors that determine death and serious injury as a result of road crashes. These are exposure, crash rate and injury severity. Exposure refers to the amount of activity where the crashes may occur. With regards to road traffic this is measured by the number of kilometres a person travelled. It is however difficult to adequately measure one's exposure (Rune et al., 2005). People who drive as part of their occupation are at an increased risk of traffic crashes compared to other drivers due to their increased exposure (Taylor & Dorn, 2006). Relative to other road users they spend a significantly longer period on the road. Exposure is of course not independent of other factors like a combination of various means of transport (Rune et al., 2005). This exposure difference with other road users is estimated to be as much as 50% (Newton et al., 2013).

The likelihood of a crashes occurring is caused by a many risk factors which are linked to elements of the traffic system. These elements are road users, traffic management devices and infrastructure and vehicles. A road crash risk factor is defined as any factor which increases the probability of a crash occurring. Risk factors are statistically related to the probability of crashes occurring however, not every risk factor can be termed as a cause of the crash (Rune et al., 2005). William Haddon developed a matrix that tries to harmonize the many influences on a traffic crash. The Haddon matrix named for him systemizes these factors into four elements namely human, vehicle and environment prior to, and after the crash. Human factors are a big influence on the occurrence of traffic crashes as it impacts both passive and active safety. Elements that influence human factors include gender, age, abilities, experiences, behaviours, skills and training, attitudes, experiences and fatigue (Davidović et al., 2018).

Fatigue is well known to be a cause of traffic crashes (Merat & Jamson, 2013). Fatigue impacts motivation and mood. It also affects cognitive functions and a person's abilities. Fatigue deteriorates a person's ability to perform a function by sending signals to the body to cease an activity (Davidović et al., 2018). Fatigue is estimated to cause about 16.5% of crashes that result in loss of life and 12.5% of collisions that result in injury in the US. An estimated 20% of all traffic crashes globally are associated with driving while fatigued. Professional drivers face increased financial and economic pressures and desire to meet work schedules particularly in the logistics sector. Transport owners have been found to incentive drivers to speed, work long hours, disregard traffic safety regulations and speed limits. Fatigue as a cause of traffic crashes has however not been studied extensively (Zhang et al., 2016).

1.2. Research Area

The study area for this research is East Africa. The East African Community (EAC) is a regional cooperation organization that offers member states access to a common market as well as common services. The member states are Burundi, Kenya, Tanzania, Uganda, South Sudan, Tanzania and Rwanda (Nibigira, 2019). The headquarters of the EAC are in Arusha. The EAC as it exists currently was established in 2000 (*East African Community | African Organization*, n.d.). The African Union recognises the EAC as one of the most advanced economic and political regional blocks on the continent. The EAC is governed by the re-establishing charter of 1999. It is the ambition of the regional block to have a common monetary unit by 2024 and ultimately reach political federation (Nibigira, 2019).

FIGURE 1 Map of East Africa Map (Service, 2018).

Burundi

Burundi has an estimated population of 10,524,117. The capital city of Burundi is Bujumbura which is also the country's largest urban centre (*Bujumbura | National Capital, Burundi*, n.d.). Estimates from WHO in 2016, place the number of fatalities in the country due to road crashes at 3,651 while estimates provided by the country are 112. The estimated number of serious injuries resulting from road crashes are placed at 54,765. The country loses an estimated $ 341.34 million to road crashes which is 11.5% of the country's GDP. 65% of death and serious injuries occurring as a result of road crashes affect people between 16 and 64 years old. This is the economically productive age group which has negative effects on a country's productivity. There is a 2:1 ratio of men to women fatalities where people aged 15 to 49 are at the greatest risk. Burundi has an estimated fatality rate per 100,000 population of 34.70. The average rate of fatalities per 100,000 population in Africa is 26.6 placing Burundi above the continental average which is the highest globally (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019).

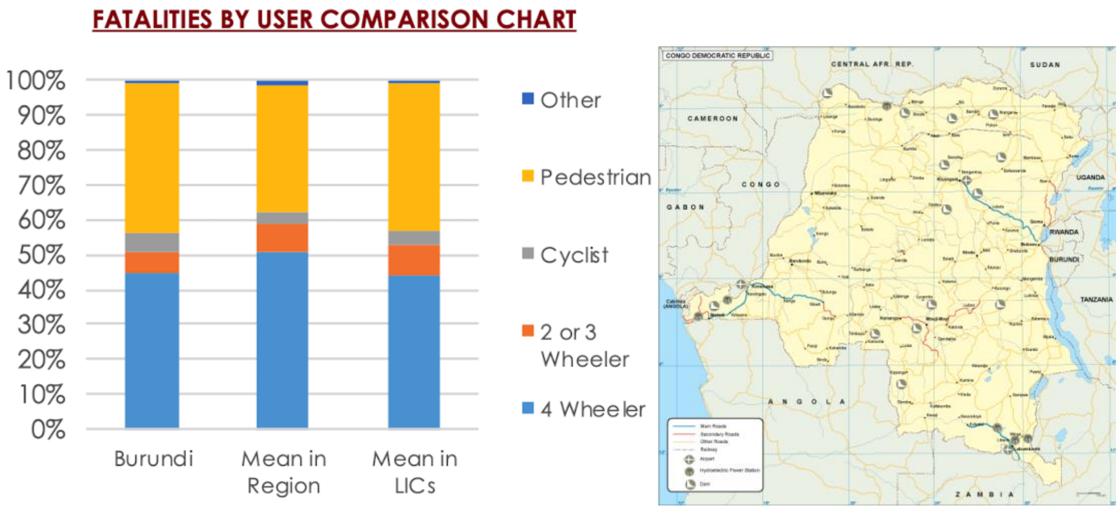


FIGURE 2 (a) Comparison between fatalities and road users groups *(*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019)* **(b) Map of Burundi** *(*Burundi Transportation Map. EPS Illustrator Map | Vector Maps*, n.d.)***.**

Kenya

Kenya is the largest economy in East Africa. Kenya has surface area of 580 thousand square kilometres (Hellström, 2010).The capital city of Kenya is Nairobi with urban sprawl as is the case in many other African cities (*Kenya | History, Map, Flag, Climate, Capital, & Facts*, n.d.). According to the most recent census conducted in 2019, the population of Kenya is 47,564,296 (Trizer, 2019). Kenya reported fatalities of 2,965 in 2016 while the WHO estimates for the same period were 13,463. The fatalities per 100,000 population provided by WHO are set at 27.80 which is close to the Africa number of 26.6. The estimated number of serious injuries is placed at 201,945. The cost of death and serious injuries as a result of road crashes is estimated at $6.55 billion which is 9.2% of the country's GDP. The productive age group of people aged 15 to 64 years makes up 67% of road crash fatalities and serious injuries. The ratio of men to women who are killed in road crashes is 3:1 with people aged 15 to 49 years being most affected. An estimated 636 years of life are affected as a result of disability resulting from road crash injuries per 100,00 people (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019).

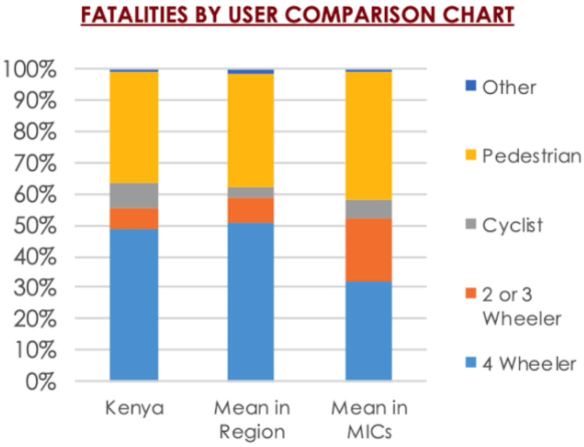


FIGURE 3 (a) Comparison between fatalities and road users groups *(*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019)* **(b) Map of Kenya** *(*Kenya | History, Map, Flag, Climate, Capital, & Facts*, n.d.)***.**

Tanzania

Tanzania is a located south of the equator. The capital city of Tanzania is Dodoma however the largest city and port of the country is Dar es Salaam (*Tanzania | Culture, Religion, Population, Language, & People*, n.d.). Tanzania has a surface area of 945 thousand square kilometres (Hellström, 2010). Tanzania has a population of 55,571,200. The reported fatalities resulting from road crashes, according to WHO in 2016, are 16,252 while the estimates provided by the country are 3,256. The estimated number of fatalities per 100,000 population is estimated at 29.20 which is above the Africa value of 26.60. An estimated 243,780 people are seriously injured in road crashes. The cost of death and serious injury resulting from road crashes is estimated to cost 4.99 billion which is 10% of the country's GDP. People aged between 15- and 64-years old account for 57% of road crash fatalities and injuries. The ratio of men to women fatalities is 2:1 with the most vulnerable age group being people aged 15 to 49 (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019).

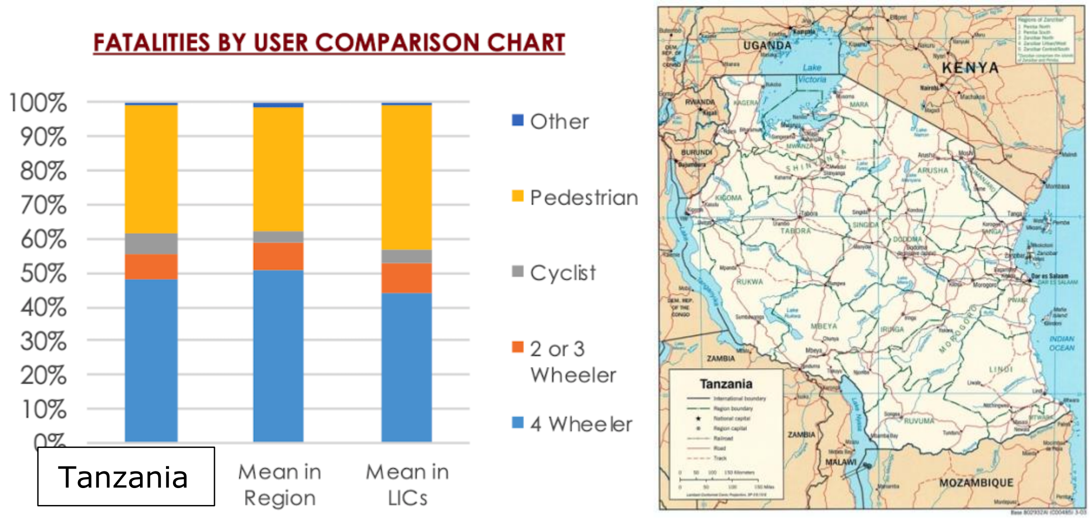


FIGURE 4 (a) Comparison between fatalities and road user groups for Tanzania *(*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019)* **(b) Map of Tanzania** *(*Tanzania Maps - Perry-Castañeda Map Collection - UT Library Online*, n.d.)***.**

Uganda

Uganda is a landlocked country located in east-central Africa whose capital city is Kampala (*Uganda | Culture, History, & People | Britannica*, n.d.). The surface area if Uganda is 141 thousand square kilometres (Hellström, 2010). Uganda has a population of 41,487,964. The country reported fatalities of 3,503 in 2016. The estimated fatalities by WHO in the same period were 12,036. The estimated number of fatalities per 100,000 population is 15.15 which is lower than the Africa estimate of the same at 26.60. About 180,540 serious injuries are incurred. The cost of death and serious injury resulting from road crashes in Uganda is estimated at $2.33 billion which is 9.3% of the country's GDP. About 61% of death and serious injury occurs among people aged 15 and 64 years. The ratio of men to women who die or are seriously injured is 3:1 with people aged between 15 and 49 years old being most vulnerable. About 869 years of life are affected by disability per 100,000 people (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019).

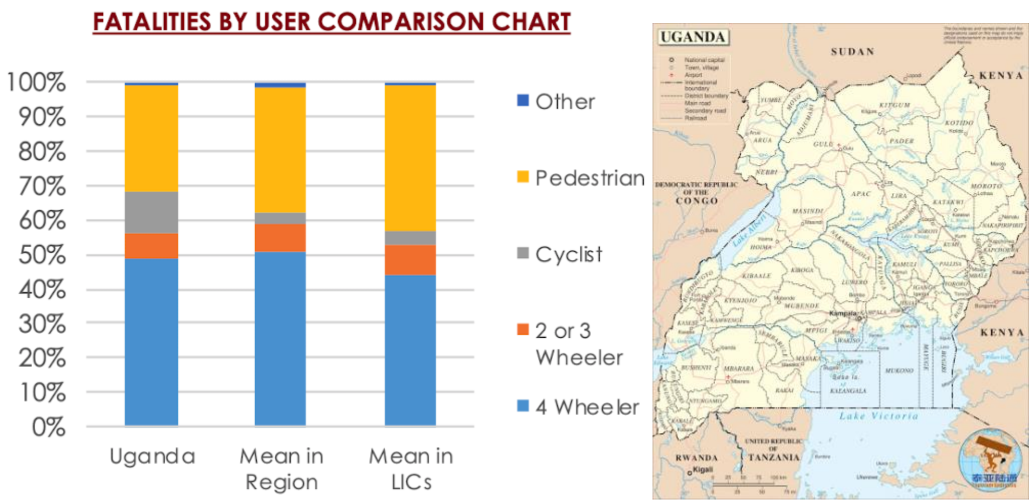


FIGURE 5 (a) Comparison between fatalities and road user groups in Uganda *(*Guide for Road Safety Opportunities and Challenges : Low and Middle

Income Country Profiles*, 2019)* **(b) Map of Uganda** *(*Uganda Transportation_Topteam Logistics (China) Co., Ltd.*, n.d.)***.**

South Sudan
South Sudan is a country located in north-eastern Africa. South Sudan was a part of Sudan until 2011 (*South Sudan | Facts, Map, People, & History*, n.d.). South Sudan has a population of 12,230,730. In 2016 the country reported road crash fatalities at 130 while the estimates provided by WHO place this number at 3661. The estimated number of deaths per 100,000 population is 29.90 which is higher than the Africa estimate of 26.60. 54,915 serious injuries are estimated to occur. The cost of death and serious injuries resulting from road crashes is estimated at $ 289.09 million which is 10.0% of South Sudan's GDP. 59% of road crash fatalities occur among economically productive age group in people aged between 15 and 64. The ratio of men to women who are killed in road crashes is 3:1. An estimated 1,072 life years are affected as a result of disability from road crashes for every 1000,000 people (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019).

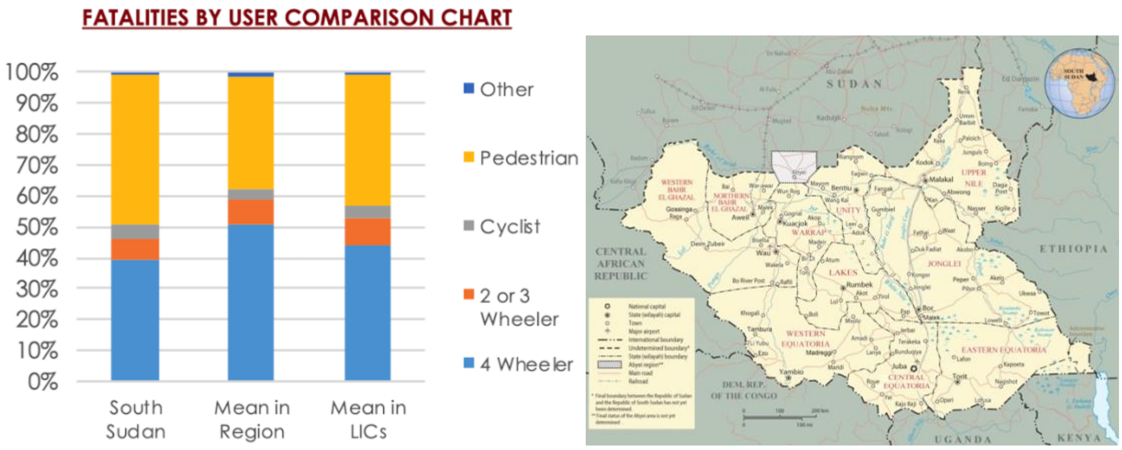


FIGURE 6 (a) Comparison between fatalities and road user groups in South Sudan *(*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019)* **(b) Map of South Sudan** *(*Map of South Sudan - Africa*, n.d.)***.**

Rwanda
Rwanda is a country located in east central Africa south of the Equator. It is landlocked and the capital city is Kigali located in the country's centre (*Rwanda | Culture, History, & People | Britannica*, n.d.). The surface area of Rwanda is 26 thousand square kilometres (Hellström, 2010). Rwanda has a population of 11,917,508 people. The number of fatalities reported by the country are 593 while the WHO fatality estimates are 3,535. WHO estimates that the number of fatalities per 100,000 population at 29.70 which is higher than the Africa estimate of 26.60. An estimated $ 835.93 million is lost to death and serious injuries because of road crashes. This is 9.9% of the country's GDP. Fatalities and injuries resulting from road crashes occur among the economically productive age group of people between 15 and 64 and represents 62% of all fatalities and injuries. The ratio of men to women who are killed in road crashes is 3:1. The life years impacted by disabilities that result from crashes for every 100,000 people are 1,138 (*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019).

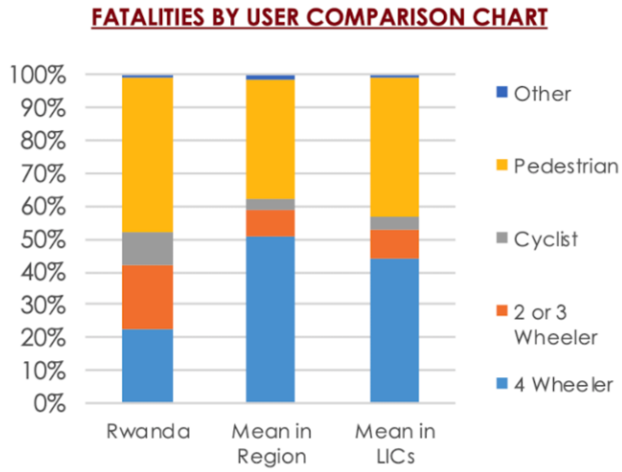


FIGURE 7 (a) Comparison between fatalities and road user groups in Rwanda *(*Guide for Road Safety Opportunities and Challenges : Low and Middle Income Country Profiles*, 2019)* **(b) Map of Rwanda** *(*Geography of Rwanda - Wikipedia*, n.d.)***.**

1.3. Problem Statement

Work related traffic crashes are the biggest cause of work-related fatality and grievous injury (Small & Breen, 2017). In occupational settings the focus when it comes to traffic crashes is often on the economic cost it is associated with. Beyond the financial losses there is loss of human life and other financial costs associated with litigation, workers compensation, insurance for the driver as well as third-party coverage (Wishart & Davey, 2004). Other costs are lost productivity, medical costs, cost of rehabilitation, delays in travel and emergency services expenses (Chen et al., 2016).

Many organizations are reactive in the design and implementation of interventions to address occupational safety. The idea is often to have one solution that should lead to an overall improvement in road safety issue. The problem of this approach is that it often does not address the true cause of behavioural factors related to the traffic crash (Wishart & Davey, 2004). According to Willis et al., (2015) interventions should be evaluated for their effectiveness and suitability to a particular issue. A one size fits all approach not only may lead to short term reversal in unwanted behaviour but also does not hold up in the long term. Instead of reactive solutions, a complex multi-dimensional approach is needed for safety in the workplace. This involves the thorough investigation and understanding of the factors that influence driver behaviour, and for our context, professional driver behaviour (Willis et al., 2005).

To understand the cause and manner of crashes in occupational settings, it is important to look at how they are recorded. Many operators record the cause of traffic crashes as having occurred through reversing, loss of control, damage while still parked, accumulated damage, having been rear ended and so forth (Wishart & Davey, 2004). This is an asset management approach towards managing vehicle safety in an organizational setting and does not take a health and safety approach (Mitchell et al., 2012). While this is an accurate representation of the manner of the traffic crash, it doesn't speak to the deeper cause of the traffic crash. It lacks important information such as the safety culture of the organization, attitudes, and perception all of which are important human factors that contribute to crashes.

Factors contributing to a crash should be assessed in terms of speed, inattention, fatigue, negligence, alcohol and drug, disregard for traffic rules, inexperience among others (Wishart & Davey, 2004). Use of alcohol, drugs and other medications and sleep disorders are known to relate to increased risk of fatigue related road crashes (Merat & Jamson, 2013). The safety climate of an organization is a big factor in whether drivers practice safe driving. For example, if the culture is to deliver goods on time and as scheduled regardless of arising conditions such as traffic or bad weather, drivers are likely to speed in order to perform as expected (Wishart & Davey, 2004).

Human factors play a significant role in the cause of traffic crashes (Passmore et al., 2019). It is estimated that human error is an underlying factor in the occurrence of road crashes between 70 to 93% of the time (Ogunleye-Adetona & Felix, 2016). The safe systems approach to road safety recognises this fact. People will make mistakes (Passmore et al., 2019). People engage in risky driver behaviour such as alcohol and drug use, hazardous overtaking, distracted driving like use of mobile phones, speeding and in this case, driving while fatigue (Rune et al., 2005; Passmore et al., 2019).

Fatigue is linked to a significant number of traffic crashes that result in death and serious injury. Fatigue is caused by a plethora of factors which includes work settings e.g., the level of workload, time the shift ends, duration, sleep disorders be it chronic or acute and effects of medications. Fatigue caused by lack of adequate sleep can lead to risky driving behaviour such as inattention or falling asleep (Bharadwaj et al., 2021). Fatigue experienced by drivers is estimated to cause between 15% and 20% of traffic crashes (Mohamad et al., 2012). Fatigue is understood to be a significant causal factor in death and serious injury associated with road crashes (Manyard et al., 2021; Chen et al., 2016).

Professional drivers experience long working hours under arduous conditions. Given these occupational characteristics of their work and limited research into this topic in the context of East Africa, it is a significant research area to pursue. Fatigue leads to decreased motivation and task performance. Fatigue results in reduced driving performance. It negatively impacts a drivers ability to make decisions, communicate, be productive, manage stress, be vigilant and be attentive (Ogunleye-Adetona & Felix, 2016). With fatigue being such an important aspect of driver safety in workplace settings this study offers to add to research done on fatigue traffic crash risk considering the setting of East Africa.

1.4. Research Objectives and Questions

1.4.1. *Research Objective*

This research is intended to understand how fatigue affects professional drivers operating in East Africa. It considers fatigue as a cause of traffic crashes with a view of offering insights into the local context and operating environment.

1.4.2. *Research Questions*

1. Is fatigue a problem among professional drivers in East Africa?
2. With what frequency do professional drivers report experiencing fatigue?
3. Do working hours influence the self-reported experiences of traffic crashes among professional drivers?
4. Does frequency of experiencing fatigue affect self-reports of traffic crashes among professional drivers?
5. Does working against driving regulations affect self-reported experiences of traffic crashes?

   Sub-Questions

   i) How does fatigue affect driving performance of professional drivers?
   ii) How do professional drivers cope with fatigue?

1.5. Significance Of the Study

Understanding the impact of fatigue on professional drivers is an important research area. Previous studies have focused on the experiences on truck drivers (Meng et al., 2015). There is limited research on fatigue in occupational settings particularly in East Africa. While professional drivers are at high risk for traffic crashes there are not frequently studied in literature (Zhang et al., 2016).

This study will look at fatigue across various industries sectors. According to Zhang et al., (2016), previous studies on fatigue have not considered the occupation of the professional driver or the nature of their work. The study will:

- Provide data on fatigue and driver behaviour through questionnaires among professional drivers in East Africa.
- Contribute to the research on professional drivers and traffic crash risk in a low-and-middle income country setting.
- Provide a basis for future studies on the issue of fatigue and it’s impacts among professional drivers.

2. LITERATURE STUDY

2.1. Fatigue As a Concept

2.1.1. *The Definition of Fatigue*

Fatigue and its effects on operator performance are a puzzling concept in psychology. Generally, one knows what fatigue feels like, but an exact definition has proven elusive (Matthews et al., 2012; Frone & Tidwell, 2015; Williamson et al., 2011; May & Baldwin., 2009). Previous studies have attempted to provide a definition. These definitions include "a feeling of weariness, tiredness, or lack of energy" (Frone & Tidwell, 2015, p.2). Fatigue is also defined as "the state of weariness after a period of exertion, mental or physical, charactetised by a decreased capacity for work and rediced efficiency to respond to stimuli (Frone & Tidwell, 2015, p. 2). Matthews et al., 2012, p. 88 define fatigue as "a lack of sufficient steady state energy to power physical and/or cognitive work". Fatigue is characterized by a feeling of tiredness and the absence of desire to act and continue to accomplish the goal. The author goes on to describe fatigue as being followed by a strong desire to cease the ongoing activity and rest. Williamson et al, 2011, p 2, defines fatigue as "a biological drive for recuperative rest".

Fatigue is challenging phenomenon as it cannot be directly observed nor objectively measured. There is currently no biological marker such as body fuild analysis or breath check for fatigue as is the case for alcohol (Dawson et al., 2021). Fatigue is subjective and relates to a sense of tiredness. In scientific settings, fatigue refers to the objective deterioration of performance linked to lack of sufficient sleep, exterting one's self physically, long periods on a task among other factors (Stern et al., 2019). Fatigue is a construct which connects a variety of factors which are presumed to cause fatigue. These factors go hand in hand with safety outcomes. Fatigue takes on different forms based on it's cause. These forms are muscular and or physical, mental and sleepiness. (Williamson et al., 2011). Fatigue, drowsiness and sleepiness are conflated and at times used interchangeably (Williamson et al., 2011). Frone & Tidwell (2015) identified three features of work-related fatigue. The first one is reduced functional capacity and extreme tiredness (Frone & Tidwell, 2015).

A feature of fatigue is the absence of energy to complete a task or experiencing reluctance to continue with it (Ogunleye-Adetona & Felix, 2016) Reduced functional capacity correlates to a decrease in the motivation and/ or ability to take part in certain types of activities or actions or react to particular stimuli. Prolonged periods of cognitive activity can lead to mental fatigue. Mental fatigue corresponds with absence of desire to proceed with an activity being done in the present, being tired, and exhaustion (Frone & Tidwell, 2015). Emotional exhaustion refers to being emotionally overextended as well as exhausted by the work one is carrying out. The consensus across the varying definitions of fatigue is a focus on extreme tiredness leading to reduced functional capacity. This sets work related fatigue apart from other forms of benign and normal feeling of tiredness that may be as a result of taking part in activities that require emotional, mental and physical resources (Frone & Tidwell, 2015).

Another feature of fatigue according to Frone & Tidwell (2015) is that the experience of reduced functional capacity and extreme tiredness correlates with the three energetic resources namely mental, emotional, and physical. Previously a distinction was made between mental and physical fatigue where physical fatigue is defined as "resulting from depletion of muscular energy" (Frone & Tidwell, 2015, p. 2) and mental fatigue is defied as "resulting from depletion of cognitive energy" (Frone & Tidwell, 2015, p. 2). Growth of service sector jobs has led to an increased focus on emotional fatigue that results from depletion of emotonal, physical and mental energetic resources (Frone & Tidwell, 2015).The third and last feature of work related fatigue is that it corresponds to the work day. Work related fatigue is experienced during the workday.Workers may face job demands where they prioritise perfomance over safety over fears of job loss from pressures from management (Anderson et al., 2017).

In summary, work fatigue takes into account three different energy resources namely physical, mental and emotional. Fatigue associated with these resources is theirfore defines as follows (Frone & Tidwell, 2015). Physical work fatigue "represents extreme physical tiredness and reduced capacity to engage in physical activity that is experienced during and at the end of the workday" (Frone & Tidwell, 2015, p. 3). Mental work fatigue "represents extreme mental tiredness and reduced capacity to engage in cognitive activity that is experienced during and at the end of the workday" (Frone & Tidwell, 2015, p. 3). Emotional work fatigue "represents extreme emotional tiredness and reduced capacity to engage in emotional activity that is experienced during and at the end of the workday" (Frone & Tidwell, 2015, p. 3).

2.1.2. *Fatigue As a Cause of Road Crashes*

Traffic crashes occur due to the complex interaction of vehicles, road users and the road environment. Safe behaviour from road users, and this case drivers, depends on their personal mental, social, and physical characteristics. It is tied to their ability to react accordingly in complex traffic situations (Różanowski et al., 2015). Fatigue deteriorates a driver's ability to drive and thus poses a risk of traffic crashes. People experiencing fatigue perform poorer and their performance is unsafe. Fatigue deteriorate response speeds and causes one to experiencing challenges paying attention (Williamson et al., 2011). On par with the lack of consensus on the definition of fatigue, there is also large differences in the criteria used on crash characteristics to identify whether fatigue led to its occurrence. There is no reliable way to determine whether fatigue was a critical factor in the incidence of a traffic crash occurring (Stern et al., 2019). However, driver fatigue is widely agreed to be a contributing factor to death and serious injury resulting from traffic crashes (Matthews et al., 2012; Maynard et al., 2021; Zhang et al., 2014; Zhang et al.,2020; Du et al., 2016; May & Baldwin, 2009).

In the UK about 20% of road crashes can be attributed to fatigue while in Australia this number is about 40% (Merat & Jamson, 2013). In Europe, fatigue is estimated to cause between 10% and 20% of all road crashes (Zhang et al., 2020). International estimates for fatigue as a risk factor for traffic crashes place it as a cause of 20% of road crashes (Matthews et al., 2012). Fatigue and sleepiness are estimated to cause about 15% to 20% of commercial vehicle fatalities (Maynard et al., 2021; Mohamad et al., 2012). These are just estimates and it is generally agreed that the true numbers are much larger. Identifying fatigue as the cause of a crash is challenging because it is often a determination of exclusion rather than inclusion. It is also likely to rely on self-reports which drivers may withhold out of fear of legal recourse or insurance purposes (Williamson et al, 2011; Matthews et al., 2012).

In workplace settings, factors like safety culture of the organization and perceptions of excessive work demands contribute to safety risk. The safety culture of an organization, particularly the perception of it, has been studied previously. These studies have found that there is a relationship between perception of safety in an organization and traffic outcomes such as self-reported involvement in traffic crashes and road safety behaviours (Mamo et al., 2014). Drivers of private cars are estimated to experience 50% less traffic crashes than those driving a company car (Mitchell et al., 2012). Driving can be a monotonous task particularly at night on highways and drivers have been known to experience "highway hypnosis". This is a phenomenon where the driver loses conscious awareness resulting from consistent road conditions particularly on long stretches (Williamson et al., 2011; Matthews et al., 2012).

Stresses experienced in the course of their work negatively impacts the safety and health among professional drivers (Taylor & Dorn, 2006). Professional drivers experience time pressures related to deliver times or income quotas, traffic congestion to a higher degree as they spend more time on the road relative to other road users as well as negative moods and irritability. Work related stresses through feelings of anxiety and irritation take away mental energetic resources away from the task of driving (Taylor & Dorn, 2006). Fatigue negatively impacts driving performance through slower reaction times, reducing the ability to keep distance from adjacent cars, increase mental withdrawal from the task of driving and reduced steering performance (Ogunleye-Adetona & Felix, 2016). Drivers are not consciously aware when they experience withdrawal of their cognitive processing ability and attention while driving. Common responses to this feeling include compensating behaviours such as increased driving or lowered driver speeds (Ogunleye-Adetona & Felix, 2016). Traffic crashes involving fatigue tend to occur on highways which have wide pavements and conditions that favour driving for long periods of time. Studies in China have shown that driving for extended periods of time in continuous simple environmental condition cause feelings of fatigue and tension in drivers (Zhang et al., 2016).

Previous studies have looked at individual factors when studying fatigue. These factors include the gender and age of the driver. The time where drivers report experiencing highest level of fatigue was found to correlate with age. Young drivers experience fatigue earlier in the morning (Zhang et al., 2016). Males aged between 16 and 29, people working in shifts and those experiencing chronic sleep conditions are art a significant risk of experiencing fatigue (Merat & Jamson, 2013). The highest level of work-related psychological risk can be found among professional drivers. Conditions in the workplace influence driver stress and can led to health compromising behaviour such as alcohol use, smoking and unhealthy eating habits which negatively affects workplace performance (Useche et al., 2017). Stress in the workplace among professional drivers is linked to risky driving behaviours which can result in road crashes. Individual variables such as behaviour and attitudes and environmental variables can be addressed using driver training (Useche et al., 2017).

The drivers' age, gender, level of experience and skill are considered to be potential risk factors for traffic crashes (Rolison et al., 2018). Drivers with minimal experience in China were found to take in a lot of information which consumes a large amount of energy and thus become fatigued faster. On the other end, drivers with far-reaching experience were overconfident in their ability to manage emergencies which also poses an increased crash risk (Zhang et al., 2016). Other risk factor for traffic crashes occurring include is speed, reckless driving, committing traffic violations and use of alcohol and drugs. These risk factors are factors are particularly visible among younger drivers and more so among male drivers. Among older drivers, driving error, failure to yield for right of way, non-compliance with traffic signs and signals, improper lane changes among others caused collisions (Rolison et al., 2018).

The road condition and environment have an impact of fatigue experiences of the driver. The type of road, for example rural versus urban, has an impact on crash risk. More traffic crash risk is found with rural roads than urban roads (Wills et al., 2009). The complexity and dynamic nature of a road also has an impact on fatigue. According to Zhang et al., (2016), previous research has determined that a change in the condition of a road from being simple to complicated negatively impacts fatigue of the driver. In the US, about 59% of driving behaviours linked to fatigue occurs on multi-lane interstates where the speed is above 55 miles/h and that about 23% of fatigue related driving behaviours were found to happen on two-lane public roads with speed limits above 45 miles/h. This is occurring while only 8% of fatigue related driving behaviours occur in local cities or adjacent public roads (Zhang et al., 2016).

An iRAP survey in 2010 of roads in Uganda showed that 17% of the road network scored a 3-star rating for vehicle occupants and 34% and the same network scored a safety rating of 3-star pedestrians. iRAP methodology looks at road safety countermeasures built into the road to access the safety. (Ogunleye-Adetona & Felix, 2016). Unsafe roads contribute to the occurrence of traffic crashes as the road environment is a contributing factor (Rune et al., 2005). This poor road condition contributes to fatigue.

2.1.3. *Causes Of Fatigue*

Fatigue in drivers is a known risk factor for traffic crashes. It is not only important but neccesary for fatigue to be detected automatically (Hu, 2017). To address a problem, it must first be understood. With fatigue, there is an abscence of biological markers that can be identified as is the case for alcohol use through blood alcohol concentration. A biological marker may be developed in the future but at present, none is available (Matthews et al., 2012). Fatigue can be categorised in two ways, as either being chronic or acute (Ogunleye-Adetona & Felix, 2016). Fatigue can also be categorised according to it's causal factors as either sleep-related (SR) or active and passive task-related (TR) (May & Baldwin, 2009).

Sleep related fatigue is caused by lack of or poor sleep, internal body clock, periods of extended wakefulness, and circadian rhythm related to time of day. Task related fatigue is caused by characteristics related to driving such as time taken on a task, monotonous or repetitive task and high task demand (May & Baldwin, 2009; Ogunleye-Adetona & Felix, 2016). Fatigue can also be related to medical conditions such as sleep apnoea which affect rest patterns (Williamson et al., 2011; Ogunleye-Adetona &Felix, 2016). The driving environment and the task of driving itself causes task related fatigue. Active and passive TR fatigue can cause fatigue in drivers. Active fatigue is related to driving conditions and mental load associated with the task while passive fatigue is associated with low task demand periods such when driving is primarily automated (May & Baldwin, 2009).

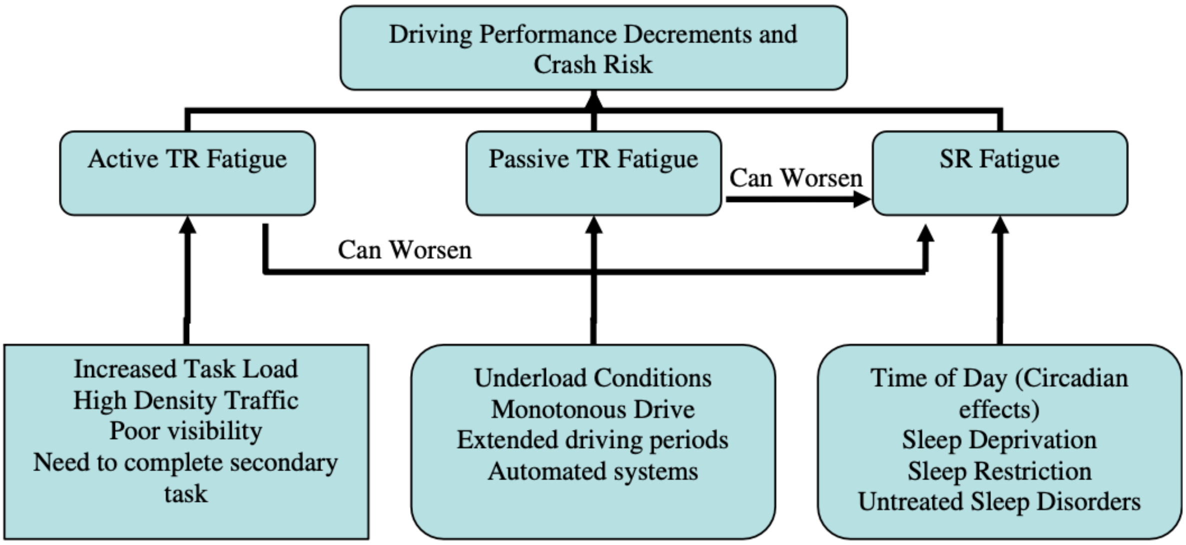


FIGURE 8 A model of fatigue (May & Baldwin, 2009)

Circadian rhythm is an internal biological clock that coordinates physiological aspects such as body temperature, digestion, sleep, performance, and daily activities. A persons circadian rhythm has a direct impact on the effects of fatigue (Ogunleye-Adetona & Felix, 2016). The circadian rhythm is characterised by a pattern of sleep and wakefulness that follows a 24-hour pattern. The likelihood of one falling asleep and how long they do sleep is linked in large part to the body clock with highest levels occurring around 06:00 under normal conditions. The effect of circadian rhythm and traffic crashes can be seen in that controlling for traffic density, the risk of traffic crash occurring at up to 10 times higher than during daytime (Williamson et al., 2011).

The homeostatic drive to sleep and sleep debt can be induced by poor sleep quality and extended periods of wakefulness. Fatigue linked to performance issues is created by severe sleep restrictions in the short term as well as partial chronic sleep deprivation. Chronic partial sleep deprivation is more severe as those experiencing it may not be aware of their level of impairment and thus not take remedial actions (Williamson et al., 2011). The quality and quantity of sleep can be disrupted by medical condition like sleep disorders which cause both acute and chronic loss of sleep. One such condition is obstructive sleep apnoea syndrome (OSAS) which is characterised by periods of disrupted sleep into wakefulness caused by obstructed or stopped breathing (Stern et al., 2019).

Time-on-task is a surrogate measure of one's exposure when determining whether an association exists between a traffic crash and risk of injury and occupational settings. It is a factor in the occurrence of workplace fatigue and is associated with mental and physical fatigue (Williamson et al., 2011). Physical and mental fatigue is affected by the nature of tasks being carried out. Where the tasks are not stimulating or the work conditions cause boredom and are monotonous, it can lead to fatigue (Williamson et al., 2011).

2.1.4. *Measuring Fatigue*

A previous study found that 17 continuous hours of wakefulness has a deleterious effect on performance like that produced by a blood-alcohol content (BAC) equivalent to 0.05 g/dL. When the 17-hour period was extended by a further 7 hours, the effect is comparable to that seen in people with a BAC of 0.1 g/dL which is past the legal limit in many countries in the Global North (Baulk et al., 2008). Measuring fatigue like, defining it, is a challenging prospect. There is no agreed upon framework by which it can be assessed. As fatigue does not have biological markers other approaches have been developed to not only define it but also measure it (Stern et al., 2019). These approaches look at fatigue as either a feeling that is subjective to a person or detrimental impact of performance of a task (Matthews et al., 2012).

The way in which fatigue is measures is likely to be based on the people doing the measuring based on the parameters they deem important. Fatigue is often measured using self-reporting and this method has become widespread because of the ease of the process (Matthews et al., 2012).

Measuring fatigue by use of questionnaires

According to Matthews et al., (2012), fatigue has been measured using questionnaires administered to people. They have been used in various settings including workplaces. Wider quality of life instruments including the Medical Outcomes Study Short-Form and the Vitality subscale are also sometimes used when measuring fatigue. Self-reported measurement of chronic sleepiness in the daytime can be done using Epworth Sleepiness Scale (ESS) and acute sleepiness is measured using the Karolinska Sleepiness Scale or the Stanford Sleepiness Scale (Williamson et al., 2011).

Elements of fatigue

Scales used to measure the feeling of fatigue look at how the respondent perceives its impact in their lives. For example, a question on the basic feeling of fatigue can include descriptors like feeling drained, tired, or sluggish. Respondents can also be asked to specify the impact of fatigue in their lives as they go about daily activities (Matthews et al., 2012). Or as is the case in this research study, while they work as a driver. Some evidence exists that some fatigue aspects are increased based on occupation. Occupation related differences relate to the demands for either physical or mental energetic resources. Some measuring instruments make this differentiation (Matthews et al., 2012).

Measurement Period

Self-reported fatigue measures may contain recall bias. Fatigue rating can be influenced by recall as it is caused by cognitive heuristics which can blur the response. Based on previous studies fatigue reports made 28 days out correlate with momentary assessments fairly well (Matthews et al., 2012).

Measuring Fatigue based on performance

Measuring fatigue based on performance involves looking at cognitive and behavioural measures that operationalize fatigue and decrease performance of a task. This can be done by measuring how the performance of a task declines over time. It can also be based on how performance lowers in conditions that are likely to cause fatigue. These conditions include working for long periods without rest. Performance measurements can be done using simulations, in a laboratory or in the field (Matthews et al., 2012).

2.1.5. *Managing Fatigue*

According to Merat and Jamson, (2013), managing fatigue can be done through measures that tackle the problem of road crashes that occur due to fatigue. These measures fall into three categories. These are measures related to the road, vehicles, and the driver. Countermeasures targeting the driver are the most logical in the effort to mitigate traffic crash risk. These measures can take the form of driver education on the signs of onset of fatigue and the negative outcomes that could result from driving while fatigued. Based on simulator testers have a drink containing caffeine before taking a short nap is an effective way of mitigating driver error caused by fatigue in the short term. Campaigns have been created around this phenomenon although their success is not clear (Merat & Jamson, 2013). Drivers may also open windows and listen to music in a bid to manage their fatigue (Zhang et al., 2016).

The improvement of in-car driver technology is another facet through which driver fatigue is being addressed (Merat & Jamson, 2013). These systems can detect driver fatigue and warn when the performance of the driver dips below a set level. The technologies motor the eye and head movement of the driver and can detect when the drivers' eyes are closed for a certain period. Detection and warning systems also monitor steering performance of the driver. The purpose of these systems is to inform the driver that they are experiencing fatigue and take remedial action such as stopping to rest (May & Baldwin, 2009). While these systems can detect driver fatigue, they still face the challenge of not accounting for specific differences in the drivers. These systems are also potentially dangerous if drivers rely on them to detect their fatigue and not self-regulate as they drive while still fatigued (Merat & Jamson, 2013). Additional research is needed to determine the effectiveness of this technology in identifying fatigue in the context of its causal factors (May & Baldwin, 2009).

Some of the popular fatigue related countermeasures that are on the road are the use of rumble strips on the edge of the road or in the centreline. Rumble strips alert the driver that they are veering off the road by creating audio-tactile vibrations as the wheels of the car drive over them. The use of rumble strips is based on research which shows that crashes related to fatigue occur with higher frequency on road sections that do not sufficiently visually stimulate the driver. Rumble devices have been determined to lead to a reduction in fatigue-related crashes by 15 – 20% and edge rumble trips by as much as 40% (Merat & Jamson, 2013). Calè (2012) conducted a road safety intervention targeting professional drivers which was successful in changing driver behaviour and resulting in decreased traffic crash risk. The study developed and made use of techniques based on empowerment, pressure of social environment and social identification instead of the traditional punishment schemes, training drivers or using intimidation. The project took a bottom-up approach incorporating attitude change which was reinforced in the social environment where participants were encouraged to display safe traffic behaviour in view of others. In this study the targeted behaviour was seatbelt use but it shows that interventions in a workplace setting targeting risky driver behaviour can be successful (Calé, 2012).

Aliakbari, M., & Moridpour, S. (2016) put forth a framework for managing fatigue driving with a focus on truck drivers. Their management approach focused on three factors namely the driving environment, economic pressure, and organizational support for driving safety. The driving environment is composed of three elements: the regular driving schedule, regular rest periods and ability to control trips particularly incoming journeys. Occupational drivers are at high risk when making trips against their circadian rhythm cycle (Ogunleye-Adetona & Felix, 2016). Trips schedules should be designed to have drivers working during regular hours, have in built rest periods and places to sleep as well as have the ability to pre-determine their driving schedule.

Economic factors such as customer demands and production models like just-in-time but a strain on drivers who might still have to meet the demands. This is coupled with "streamlining" driver numbers by some organizations and even less people are available to meet the demands. Finally, the organization must support road safety among its drivers. It is a shared responsibility. Through establishing a culture of road safety, offering incentives, and training, an organization can promote road safety among its drivers. They need to put safety above profitability (Aliakbari, M., & Moridpour, S.,2016).

2.2. Human Behaviour

Overcoming deep-rooted behaviour can be difficult. This is also true for one-time behaviours which are working against a powerful gradient. The gradient could be social, psychological, or environmental. The behavioural change wheel (BCW) is an evidence-based system of behaviour designed to enable intervention designers to make the move from behavioural analysis of a problem to designing the intervention. The BCW analyses and distils 19 behavioural change frameworks that exist in literature. Central to the BCW is the COM-B model. COM-B is an acronym for capability, opportunity, motivation, and behaviour. The BCW acknowledges that behaviour is part of an interrelating system involving the COM-B elements. To achieve a permanent change avoid slipping into previous behaviour requires a change to at the very least one of these elements. (Michie et al., 2014)

When it comes to work-place driver safety, many organizations are reactive in the design and implementation of interventions. The idea is often to have one solution that should lead to an overall improvement in road safety issues involving the fleet. The problem of this approach is that it often does not address the true cause of behavioural factors related to the traffic crash (Wishart, D et al., 2004). Interventions should be evaluated for their effectiveness and suitability to a particular issue. A one size fits all approach not only may lead to short term reversal in unwanted behaviour but also does not hold up in the long term. Instead of reactive solutions, a complex multi-dimensional approach is needed for fleet safety. This involves the thorough investigation and understating of the factors that influence driver behaviour, and for our context, professional driver behaviour (Willis et al., 2005).

Under BCW, intervention developers can systematically and transparently identify intervention and policy categories that are promising in achieving the desired goal.

These policy and intervention categories are summarised in the BCW as shown in figure 9. After intervention functions and policy categorised have been selected, the last step in the intervention design is to step away from the Wheel and determine specific behaviour change techniques. In addition to this, suitable delivery modes that are likely to be effective and are connected back to psychological theory (Barker et al, 2016). As shown in the figure 9 the BCW is made up of three layers. The source of the behaviour is identified in the hub. Ultimately, this is what is targeted by the intervention. After the hub of the wheel are the 9-intervention function one may arrive at after application of the COM-B examination. The last segment, the outer most layer of the wheel are the 7 policy types used to arrive at the intervention functions (Michie et al., 2014).

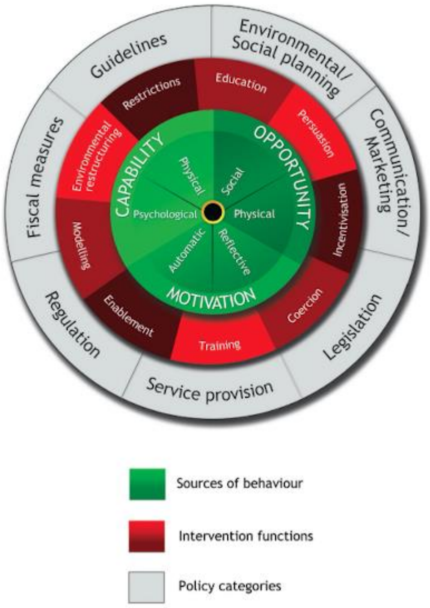


FIGURE 9 The behaviour change wheel (Michie et al., 2014)

The designing process is made up of 8 steps beginning with identification of the problem up to determining the intervention content and its implementation process. Figure 10 below shows the process broken down from stage 1 to stage 3.

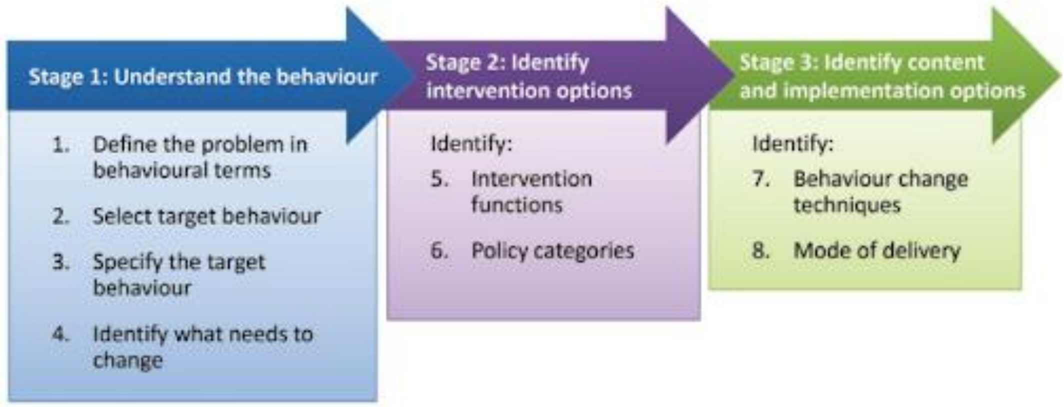


FIGURE 10 Behaviour change intervention design process (Michie et al., 2014)

2.3. Professional Drivers

Working as a professional driver requires consistent environmental awareness in complex situations. Drivers need to perform their task while still being aware of potential hazards in their environment. The stress faced by professional drivers varies based on the nature of their work and the type of vehicle they drive (Taylor & Dorn, 2006). Previous studies among European professional drivers have shown that there is a prevalence of reduced sleep time among long distance drivers (Ogunleye-Adetona & Felix, 2016).Professional driving is rife with long working hours, unskilled workers, poor health of workers and low profit margins. Drivers may work long hours with minimal social contact and those dealing with passengers may experience interpersonal conflicts. Work stresses may spill over to homelife because of working practices like rotational schedules and split shifts (Taylor & Dorn, 2006).

This study looks at professional drivers in different work settings as described below.

2.3.1. *Public Transport Sector*

The role of public transport in society is to offer access to destinations such as education centres, jobs, and opportunities. Public transport should be comfortable, efficient, affordable, reliable, and safe for all users. For public transport to serve the needs of users as it should governments step past the confines of establishing mass transit and other first and last mile services and instead consider the integration of various transport modes which includes cycling, walking, informal, semiformal and formal transport modes (Tun et al., 2020). In sub-Saharan Africa, there is a challenge when it comes to offering sustainable transport. With the explosive growth of urban centres in the post-colonial period there has been minimum success with regards to planning for transport and traffic. In many LMIC public transport is largely through both formal and informal transport operators called paratransit (Phoebe, 2017). Paratransit refers to transport that is flexible, utilizes both small and medium sized vehicles and does not have fixed schedules (Behrens et al., 2015).

A matatu is a medium sized minibus used for public transport. They are often crowded and ferry people into the city centre. The 14-seater public service vehicles have been operating in Kenya since as early as 1950 illegally. The government only recognized them as legal transport mode in 1973. They were allowed to operate unlicensed which led to chaos in the industry. It was not until 2004 through the Legal Notice 161 that a measure of structure was brought to the industry in Kenya by the then minister of transport Minister Michuki (Koimur et al., 2014). Common features of paratransit include irregular periods of operations, operating rules differ by routes and unregulated and fluctuating travel fares based on demand. Paratransit vehicles in Uganda are referred to as taxis and in Tanzania they are called dala dala. The industry is known to be dangerous and prioritized money (Phoebe, 2017). Majority of people in Kenya use public transport (Koimur et al., 2014). Paratransit used to operate alongside more large-scale organized transport system provided by and supported by the government but has quicky become the main public transport system (McCormick et al., 2013).

Paratransit is plagued by poor quality services and dissatisfied customers (Phoebe, 2017). While the causes of this are complex the context of the operating model indicated it is caused by how paratransit operates. Two main features of paratransit are the driver remuneration model and a cash-based business. The driver remuneration model operates such that the vehicle driver pays the vehicle owner either commission as an agreed weekly percentage of collected fare or a rental fee every day. The driver then pays themselves and covers operational expenses such as fuel and repairs with the remaining funds (Behrens et al., 2017). To pay the vehicle owner, matatu's operate with little to no regard for customer satisfaction and safety and often flaunt safety regulations. Fare is collected per passenger which incentivizes a rush to ferry as many passengers as possible. They also work for long periods of time as much as 18 hours a day to reach the income targets. Matatu owners are largely absent from the actual operations of the industry. They only wait for their share of collected revenue. Matatu crew work on verbal contracts with the vehicle owners and have little to no saw in the arrangement (Phoebe, 2017). Typically, matatu's are poorly managed as the owners have a hands-off approach. They condone risky behaviours of their drivers such as overseeding. The people in this sector are often unqualified and studies have shown many left educations at the high school level. The competitive nature of the industry is characterised by deviating from standard routes to avoid traffic snarl ups, picking up and dropping passengers are locations not prescribed for among others (McCormick et al., 2013).

Paratransit is largely cash based and runs on day-to-day basis. The operating costs that are accounted for are limited to the cost of fuel, labour, and vehicle maintenance. Other considerations such as the depreciation of vehicles is not included, and these vehicles continue operating after they have reached replacement age as the funds to replace them are not available. Vehicles remain in operation even in an unsafe and unroadworthy condition (Behrens et al., 2017). Paratransit operates without fixed schedules and historically data about this sector has been limited. With the widespread availability of cell phones with geo-location capability this gap can now be filled. There have been several mapping projects in Africa often led by activists who work to advance quality of life in cities by leveraging technology. The digital matatu project in Nairobi is one of the earliest such projects and is well known. In 2014 the public transit map for Nairobi was launched which resulted from the project. Other cities where similar efforts have been made includes Kampala, Addis Ababa, Lusaka, Accra, Cape town, Cairo, Maputo, Duala among others (Klopp & Cavoli, 2019).

Important features to understand about paratransit that make it different from scheduled government backed transport were detailed below (Finn, 2012):

1. Paratransit often has its roots in illegal or unauthorised operations. In places where the regulatory framework has not caught up to recognise and accept paratransit they continue to operate outside the confines of formal transport.
2. Paratransit develops to meet the transport needs of the market created by gaps and failures in the existing transport services. Paratransit is flexible and adjusts to meet demands.
3. There is an adversarial relationship within the sector as their market position is not protected short of by their own numbers and will.
4. Transport policy leans towards eliminating the sector with stakeholders believing it should be replaced, transported, or eliminated altogether.
5. Often the business structure is not a corporate one with many individuals owning a small number of vehicles. This leads to sector operators focusing

on their own advantages in the market instead of optimizing across the sector.
6. Paratransit is a private for-profit business and is characterised by entrepreneurial spirit and oven does not respond to efforts to manage or constrain them.
7. The stakeholders in the industry are discrete and competitive tension may exist among them.

Paratransit vehicles are not operated homogenously. There are different levels of strategic thinking, investment and labour put it as it is a private business operated for profit. Paratransit vehicles are owned by either individuals or private entities (McCormick et al., 2013). In Kenya, matatu's are required to be part of a SACCO to receive a public service vehicle licence (PSV licence). SACCO's were formed to consolidate disparate transport business operating the same route that were competing against each other who instead came together and saw increased profits. While originally joining a SACCO was voluntary the government made it a requirement in 2010. SACCO operations are governed by the Cooperative Societies Act which lays out the procedures and rules for operation. (Behrens et al., 2017). McCormick et al., 2013 categorised the organization of the industry into low, moderate and high levels of organization. Organization here refers to the systematic and ordely structure with which they operate. Typical matatu's fall within the low level, management compaies come in as the first group in the moderate level and larger transport vehicle busineses with several vehicles also fall on the higher end on moderate organization. In their study, no vehicles in Nairobi fell into the high organization category. The table below highlights the features of the different operation strategies based on level of organization.

TABLE 1 Strategy and Organization of matatu Businesses (McCormick et al., 2013)

Strategy	Low Organization	Moderate organization	High organization
Business ownership, structure, and levels of investment	Individual, owning one or more vehicles	Group ownership (family, partnerships, cooperatives, limited companies)	Limited companies
Financing	Self, family, and friends	Self, family, and banks	Investors and banks
Pricing	Flat zoned, variation with traffic and weather	Flat zoned, monthly coupons and smart cards	Seasonal tickets which are transferable, no deviations allowed
Operations repair and maintenance, recruitment	Individually undertaken by each operator	Done by management companies	Centralized
Regulatory compliance	Low or non-existent compliance	Complies with some, but not all, regulations	Full compliance

TABLE 1 Continued from previous page (McCormick et al., 2013)

Strategy	Low Organization	Moderate organization	High organization
Routes and vehicle types	• Operate in one route allocated by TLB/ control of routes by gangs • Considerable deviation from routes • Mainly 14-seaters	• Operate in one or more than one routes; routes controlled by cooperatives or management companies; some deviation from routes • Mainly 25–55-seater minibuses	• Routes controlled by legally mandated transport authorities; complete adherence to assigned routes. • Mini and full-size buses
Regulatory compliance	Low or non-existent compliance	Complies with some, but not all, regulations	Full compliance
Promotion and advertising	Individual promotion through touting at stages	Some advertising on vehicles	Centralised advertising strategy
Customer relations	Not emphasized	Guidelines given	Emphasized
Business linkages and networking	Mainly personal ties and linkages through informal groups	Mix of formal and informal linkages	Predominance of formal linkages

2.3.2. *Long Haul Trucking Industry*

The transportation of goods is a critical part of any economy. Truck drivers play an important role by ferrying goods from one place to another (Malinga et al., 2021). Truck drivers are vulnerable to poor health outcomes compared to rest of the population particularly in the African region (Samanta et al., 2017). This is because many countries in the region do not have well developed health systems (Malinga et al., 2021). Professional drivers in the trucking industry have a documented higher risk of serious health conditions such as HIV. Transactional sex at ports and important transport locations has led to high prevalence of HIV infection among professional drivers (Morris & Ferguson, 2007). Truck drivers experience a higher burden of both communicable and non-communicable diseases. They at risk for respiratory mental, muscular, cardiovascular and other diseases (Samanta et al., 2017).

Trucking operations are often carried out with a driver and assistant (Morris & Ferguson, 2007). Drivers often work under challenging conditions and can be away on a trip for weeks. They spend long periods of time away from social support from family and friends. They face threat of carjacking, loneliness, long periods with little activity particularly at the border. The working conditions faced by truck drivers means they are rife for high health risk through engaging in risky behaviour (Vries et al., 2020). Occupational characteristics of truck drivers sector also lend themselves to the poor health outcomes of drivers. They often have irregular working schedules, long driving hours, they face injury from loading and offloading the vehicle, unhealthy eating habits, inadequate access to healthcare and of interest in this study, the risk of road crashes (Lalla-Edward et al., 2016).

Truck drivers face a traffic crash risk 20 times higher than that of other motorists. They are at an increased risk for traffic crashes due to the long hours spent driving and irregular working schedules where they continue driving for subsequent days which increases fatigue and stress risk. Truck drivers also experience inadequate sleep which increases levels of physical fatigue and decreases phycological arousal. A decrease in psychological arousal is a risk actor of fatigue (Matthews et al., 2012). Truck drivers may choose to continue driving while feeling fatigued due to pressure from their job and time. They may be unable to accurately judge how diminished their skills are by fatigue until faced with fatigue related dangers such as drifting from their lane or experiencing near collisions (Matthews et al., 2012).

2.3.3. *Ride Hailing Car and Taxi Service Industry*

The era within which technology determines how products and services are made available, utilized, and communicated is referred to as the fourth industrial revolution. In this space there is a blurring of both physical and technological processes in the area of business (Ponder, 2019). One area the fourth industrial revolution has shaped is the transport sector. Advancements such as autonomous vehicles, drones, and ride hailing have made entry into the transport sector (*This Is the Complete List of Major Ride-Hailing Companies in East Africa*, 2018). In East Africa, e-hailing is provided by technology companies such as uber, Taxify, little cab, Swvl who have made entry into the market ('Best Taxi Hailing Companies in East Africa', 2020). E-hailing is a process whereby a transport user can locate a taxi or other type of transport service using an application on their phone. The provider of these services is called a Transport Network company (TNC) who connects the request for transport to a vehicle belonging to a user of their platform. This sector has created fierce competition in the taxi industry by increasing the number of vehicles operating and making it easy to source a vehicle (Weru & Mugo, 2020).

Mobile applications used by e-hailing companies have transported the transport sector by providing on-demand transport options (Ponder, 2019). E-hailing companies differ from other traditional taxi service providers because of their business model. They separate the function of acquiring and maintaining a vehicle fleet and instead connect independent vehicle owners to clients (Weru & Mugo, 2020). The vehicle owners are contractors and responsible for their own vehicles and thus the TNC avoids overhead costs associated with maintaining a transport fleet. Free of the costs associated with setting up a vehicle fleet, TNC's can invest in building the technological framework used to map and bill users (Ang'asa, 2017). A report in 2018 found that 80% of people in Kenya are internet users (Ponder, 2019). While about a third of the population of adults in East Africa is illiterate, by the end of 2009 50 million people in the region were mobile subscribers. The access to mobile phones is about at 40% of the total population. Mobile phones are this the main medium for dissemination of information (Hellström, 2010). Kenya leads the continent with subscription numbers of 91% for mobile phones. The average across the continent is 80% (Namunwa, 2019).

Compared to other countries in the world, Kenya has the highest number of people who access the internet from their phone as compared to from a desktop. This number is estimated to be at 83%. The increase in access to the internet is can be in part attributed to falling mobile phone process and affordable data plans (Namunwa, 2019). In Uganda, the penetration of the internet is at 19% with over 7 million people having access to the internet (*Uganda Internet Users*, n.d.). Rwanda had 4.12 million internet users as of January in 20021 which was a 24% increase from 2020 (Kemp, 2021b). In January 2021 there were 15.15 million internet users in Tanzania which is a 3% increase from the same time in 2020. Internet penetration in Tanzania is at 25% (Kemp, 2021c). In Burundi there are 1.61 million people who use the internet as of January 2021. This is a 39% increase from the previous year. The rate of internet penetration stands at 13.3% as of January 2021 (Kemp, 2021a). South Sudan on the other hand has over 800 thousand intent users. Between 2019 and 2020 there was a 1% increase in the number of internet users. South Sudan has the lowest internet penetration rate among these countries at 8% (Kemp, 2020).

A feature of the e-hailing industry that is not found in the matatu industry is a portion of driver earnings are paid to the TNC. Uber and Bolt collect 25% commission (Wambu, 2021), Little 15%, and InDriver 10% (Tanui, 2019). With stiff competition among many TNC’s there have also mean price wars with companies lowering their prices to remain competitive (Wambu, 2021). This has resulting in strikes, and which eventually end because the drivers go back to work. Drivers who took out loans into to enter the industry are faced by the additional pressure of having to pay them back. Uber Chap Chap was launched to offer loans amounting to as much as Kenya shilling (Ksh) 1 million to acquire a 800cc Suzuki Alto which has a low resale value (Tanui, 2019).

FIGURE 11 Popular E-hailing apps in Kenya (Tanui, 2019)

In 2020 during the COVID-19 pandemic, dozens of vehicles were sold because the drivers were not able to make the payments. Drivers in these programs must balance making enough money for their daily upkeep and repaying back said loans. Research on this topic has found that about 50% of drivers in this industry are earning less than the minimum wage (Tanui, 2019). The price competition between TNC's and the commissions they charge is in effect exploitative of drivers. The TNC's bear no responsibility of associated costs of operating a vehicle such as fuel and maintenance. TNC companies such as uber justify taking a quarter of the drivers earning by providing the operating infrastructure and customer support. In 2021 fuel prices went up in Kenya which increased the operating cost and eats into the profits drivers make (Wambu, 2021).

2.3.4. *Transport In the Tourism Industry*

The United Nations World Tourism organization defines tourism as "*a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes*" (*Glossary of Tourism Terms | UNWTO*, n.d.). An estimated 5.1 million people visited East Africa in 2017 making the region the number one tourist destination in East Africa in sub-Saharan Africa. Tourism is a key pillar for economic development in the region. It contributes to up to 8.9% of the regions GDP and employees an estimated 2 million people (Nibigira, 2019). Road transport is key for access to many tourist destinations. Reaching some of these locations is only possible seasonally with poor road quality contributing to the cost of vehicle maintenance through damage. In Kenya for example, traffic jams lead to a cost of $746,000 in losses in 2007 through increased fuel consumption (Christie et al., 2014).

People employed in the transport sector are largely considered to be low or unskilled workers. Working in the tourism sector often involved irregular working hours, high turnover rates and low levels of collective bargaining. It is also characterised by high and low seasons either by virtue of being weekends versus weekdays or seasons of the year (De Beer et al., 2014).

3. RESEARCH METHODOLOGY

3.1. Participant's recruitment

Professional drivers considered for this research were people who work as drivers in East Africa. The sectors of work included in the study were long haul trucking, commuter public transport, long distance public transport, private driver for a companies or individuals, taxi or car service, ride hailing car or taxi service and tour company drivers. Drivers in these categories were contacted through fleet managers for organizations operating within this region, contacting managers at organizations that maintain vehicle fleets, joining common interest groups on social media (e.g., truck driver groups, road safety groups, ride hailing driver and partner groups), and sharing on social platforms. Professional drivers were also recruited by reaching out to driving school instructors, non-governmental organizations that conduct driver training, public transport operators and road safety advocates that interface with professional drivers.

For this purpose, a campaign message and poster were created to explain the purpose of the study and encourage people within the research group to fill out the survey. On social media, influential members of common interest groups, typically group administrators, were asked to share the survey link, poster, and message to encourage members to fill out the survey. Fleet managers, public transport operators, road safety advocates, non-governmental organizations and driving school instructors were requested to share the same information through driver communication channels. Managers in organizations that maintain vehicle fleets were requested to refer the survey link and research details to the related department for distribution.

3.2. Survey Administration

The survey was administered online using Qualtrics. Respondents were given a link which they used to access the survey and fill it out. This was done using a device like a phone or computer and access to the internet.

3.3. Questionnaire Design

The questionnaire was adapted from one used *in "The Relationship of Lifestyle Behaviour and occupational characteristics to selected health problems among truck drivers in Taiwan"* by Shu-Ling Hung. The questionnaire was developed to meet the requirements of this study. The survey was available in English and Swahili. The questionnaire used has four sections. Section one asked limited socio-demographic information such as gender, age group, years of experience, nature of work and country. Section two asked questions on fatigue such as whether fatigue was a problem personally to the respondent or in their industry, frequency with which they experienced fatigue and at what times. Section three asked questions on driver behaviour such as how fatigue affected their driving, factors that contributed to their fatigue and mitigation measures used. Section four asked respondents whether they had experienced a traffic crash in the preceding 12 months and if they did experience a traffic crash, whether it resulted in injury or property damage. The complete questionnaire is available in appendix 8.1.

3.4. Data Analysis

In total, 546 responses were received. These responses collected were maintained online on Qualtrics. The data was exported into excel and review made for the completeness and usability of the responses. For analysis purposes, incomplete responses were removed, except for responses affected by the technical issue where some questions were not displayed to respondents, and the remaining responses were 400. Descriptive analyses of responses from the survey were performed and the data collected represented in the form of graphs and tables. Chi square test and binary logistic regression were selected for hypothesis testing and to determine the effect of specified variables. Data used in the tests was coded to a numerical scale to facilitate analysis which was performed using SPSS.

3.4.1. Chi Square Test

The Chi-Square test of independence is a statistical test used in hypothesis testing. Chi-square ($\mathcal{X}^2$) allows the researcher to identify whether there is a significance in observed differences and which categories account for differences seen (McHugh, 2013). In hypothesis testing, chi-square tests whether is an association between two or more groups, criteria, or population. This means it checks the independence of given variables. Chi-square test is used for categorical data such as age and gender. It is not used for continuous data that can be measured and counted like height and weight (Rana & Singhal, 2015).

Data collected in the survey is largely categorical and thus the chi-square test is suitable for analysis. Chi-square is used to test the following hypotheses.

Fatigue

H_0: Frequency with which professional drivers report experiencing fatigue does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Frequency with which professional drivers report experiencing fatigue has a significant association with self-reports of experiencing of traffic crashes.

Nature of work

H_0: Nature of work (e.g., long distance public transport, long haul trucking) does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Nature of work (e.g., long distance public transport, long haul trucking) has a significant association with self-reports of experiencing of traffic crashes.

Age

H_0: Age of professional drivers does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Age of professional drivers has a significant association with self-reports of experiencing of traffic crashes

Years working as a driver

H_0: Years working as a driver does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Years working as a driver has a significant association with frequency with self-reports of experiencing of traffic crashes

Days worked a week
H_0: Days worked a week does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Years working as a driver has a significant association with self-reports of experiencing of traffic crashes.

Hours worked a day
H_0: Hours worked a day does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Hours worked a day has a significant association with self-reports of experiencing of traffic crashes.

Description of work schedule
H_0: Description of work schedule does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Description of work schedule has a significant association with self-reports of experiencing of traffic crashes.

Time of the day professional drivers are most likely to feel fatigued
H_0: Time of the day professional drivers are most likely to feel fatigued does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Time of the day professional drivers are most likely to feel fatigued has a significant association with self-reports of experiencing of traffic crashes.

Working against driving regulations
H_0: Working against driving regulations does not have a significant association with self-reports of experiencing of traffic crashes.

H_1: Working against driving regulations has a significant association with self-reports of experiencing of traffic crashes.

3.4.2. Logistic Regression

Regression analysis is a research method that is used to determine the associations that exists between (several) independent variable(s) and an outcome. The independent variables are frequently referred to as covariates, explanatory variables, and predictors. Regression analysis also lets a researcher assess the extent to which one can predict an outcome from a set of independent variable (Stoltzfus, 2011). Regression models gauge the degree to which the causal relationship that exists between variables and outcomes can be seen in the data (Meurer & Tolles, 2017). One of the methods under regression analysis is linear regression where the response variable is a continuous outcome i.e., outcomes like temperature, height and weight that can be counted and divided into small increments which are meaningful. Linear regression assumes that the independent variables and the outcome variable have a relationship that is linear (Stoltzfus, 2011).

The base equation with multiple variables for linear regression is as follows (Stoltzfus, 2011):

$$\hat{Y} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_i X_i$$

However, linear regression is not suitable for all data types including the data collected for this study. Logistic regression differs from linear regression in that it estimates the probability of one of two outcome categories against the other and not an estimated continuous outcome (Stoltzfus, 2011). While logistic regression is most often used with two dependent outcome variables, it can be used where the outcome variable has more dependent variables i.e., multinomial or polynomial dependent variables (Wright, 1995).

In logistic regression, the chance of one outcome occurring over another is represented by the equation below (Sperandei, 2014):

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1\beta_1 + \beta_2 X_2 \ldots \beta_m X_m$$

where β_i is the regression coefficient related to the group being referenced and π is the probability of the event outcome (Sperandei, 2014).

According to Stoltzfus (2011), the following are considered in interpreting the results of a logistic regression model:

- Determining how well the model fit overall. This is done to assess how well the model created by the logistic regression fits the collected sample data. This is done commonly using residual deviances and chi-square statistics. Another measure used to determine the model fit include Hosmer-Lemeshow goodness of fit tests where the sample is divided into equal sections and according to the probabilities estimated for the outcome. The lowest section is made up of outcomes that are likely to be experienced. If the model fit is good the primary outcomes would be in the higher sections.
- Looking at individual variable results and making interpretations. In logistic regression this is done by observing the odds ratios (ORs). The strength of the contribution of the independent variable to the outcome is shown by the ORs. ORs are the odds, for each independent variable, of the outcome occurring $\hat{Y}$ against not occurring $(1 - \hat{Y})$. Where there is only one independent variable the OR is deemed to be "unadjusted" as the influence of other variables has not been considered. Where multiple independent variables are used in the model then it is "adjusted" as the contributions of the other variables are adjusted for in the model.

Binary logistic regression was used to test the following hypothesis.

H_0: Adjusted for age, gender, years working as a driver, number of days a week worked, number of hours a day worked, and description of work schedule; frequency of experiencing fatigue is not a significant predictor of self-reports of experiencing of traffic crashes.

H_1: Adjusted for age, gender, years working as a driver, number of days a week worked, number of hours a day worked, and description of work schedule; frequency of experiencing fatigue is a significant predictor of self-reports of experiencing of traffic crashes.

4. DATA ANALYSIS AND RESULTS

4.1. Descriptive Analysis of Respondents

546 responses to the questionnaire were received. Of those, 400 remained after cleaning and used for analysis. Of those, 368 were male and 32 indicated they were women. The data used in statistical analyses records responses that were registered in full. Some questions were not answered by all respondents due to technical challenge in setting up the questionnaire online. Where this occurred, it is indicated in the description. The survey elicited responses about various parameters related to fatigue.

TABLE 2 Characteristics of professional drivers (Source: Author)

Variable	Frequency	Percentage
Gender		
Male	368	92
Female	32	8
Age		
18 – 24	17	4.25
25 – 34	126	31.5
35 – 44	157	39.25
45 – 55	80	20
Over 55	20	5
Experience		
Less than 5 years	63	15.75
5 years to 10 years	183	45.75
More than 10 years	154	38.5
Nature of Work		
Commuter public transport vehicle	69	17.25
Long haul trucking	118	29.5
Long-distance public transport vehicle	37	9.25
Private driver for a company or individual.	58	14.5
Ride hailing car or taxi service (Uber, taxify, bolt)	21	5.25
Taxi or cab service	51	12.75
Tour company, tourist related activity	8	2
Other, please indicate which	38	9.5
Country		
Burundi	1	0.25
Kenya	131	32.75
Uganda	144	36
Tanzania	117	29.25
Rwanda	7	1.75

Table 2 shows the characteristic variables of respondents. Majority of respondents (92%) are male while only 8% were female. Most respondents (70.25%) were between 25 and 44 years of age. Most respondents (84.25%) had more than 5 years of experience. The largest group by nature of work were those in the long-haul trucking sector (29.5%) and the smallest were tour company or tourist related activity (2%).

4.1.1. *Average Working Hours of Respondents*

Professional drivers are known to work long hours. The questionnaire asked respondents on average, how many days a week they worked and how many hours a day they worked. Majority of respondents (84.75%) reported working more than 5 days a week. Nearly all respondents (97%) reported working more than 6 hours with 54% of all respondents working more than 12 hours a day on average. This is consistent with what is known about professional drivers and the relatively long periods of time they spend driving.

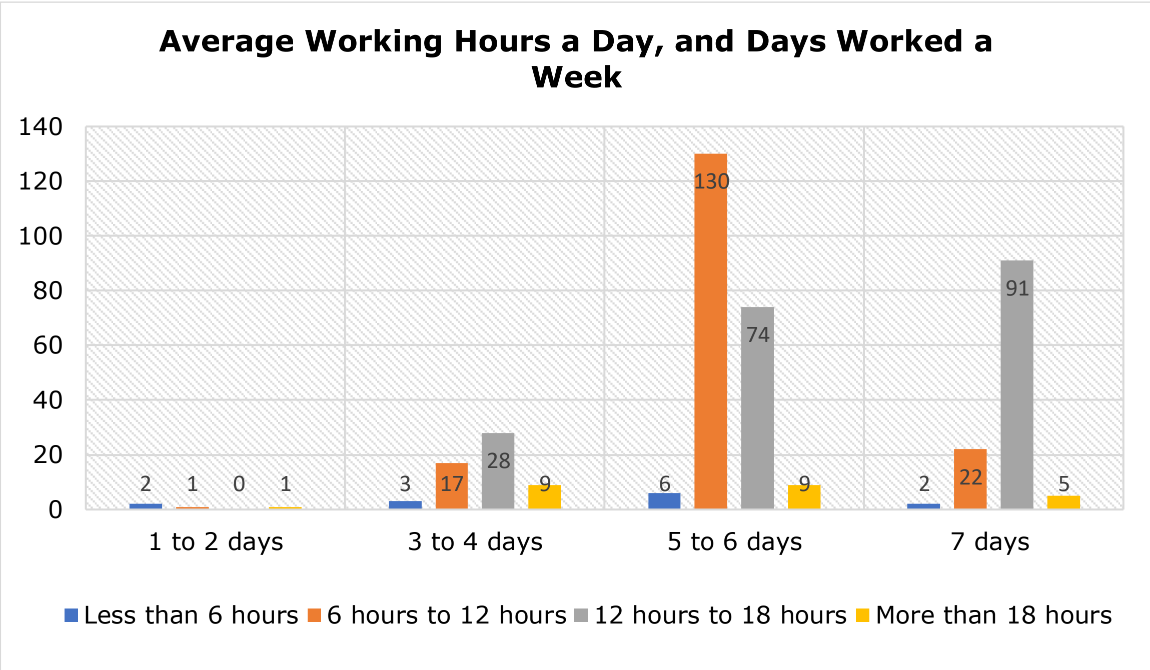


FIGURE 12 Working hours a day, and working days a week (Source: Author)

TABLE 3 Percentage of respondents and their average working hours a day, and working days a week (Source: Author)

Working Hours, a day and days worked a week	**Less than 6 hours**	**6 hours to 12 hours**	**12 hours to 18 hours**	**More than 18 hours**	**Total**
1 to 2 days	2	1	-	1	4
Percentage	50%	25%	0%	25%	100%
3 to 4 days	3	17	28	9	57
Percentage	5%	30%	49%	16%	100%
5 to 6 days	6	130	74	9	219
Percentage	3%	59%	34%	4%	100%
7 days	2	22	91	5	120
Percentage	2%	18%	76%	4%	100%

4.1.2. *Work Schedule*

A source of pressure and stress among professional drivers is the need to rush to drop off a load or passengers to collect the next load. An interest of this research was to understand whether the professional drivers surveyed had control over their working schedules. 67% of respondents indicated their work schedules were either determined by them or were determined by their employer and was predictable. Having predictable working hours or being able to plan their work schedule should make it possible for professional drivers to plan breaks and stop driving to recuperate. However, financial pressures as that experienced by many in this sector may cause them to continue working to make more money as their income is tied to trips made or passengers carried.

TABLE 4 Determination of work schedule and nature of employment as a percentage (Source Author)

	I own the vehicle I drive	I drive on behalf of a private individual	I drive for a company	I drive for a government institution or agency	Total
Determined by you	32	48	19	-	99
Percentage	32%	48%	19%	0%	100%
Set by your employer and is predictable	7	35	105	22	169
Percentage	4%	21%	62%	13%	100%
Set by your employer, varies and is unpredictable	10	21	75	6	112
Percentage	9%	19%	67%	4%	100%
Other, please indicate which	1	3	16	-	20
Percentage	5%	15%	80%	0%	100%

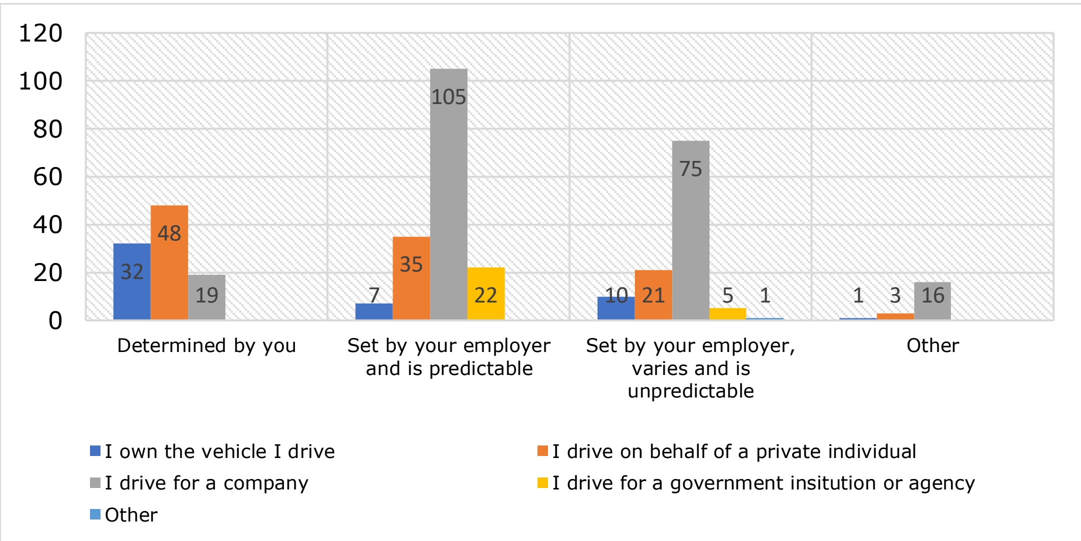


FIGURE 13 Determination of work schedule and nature employment (Source Author)

4.1.3. *Fatigue*

This study is primarily focused on how fatigue affects professional drivers. Several questions in the questionnaire were geared towards this goal. Respondents were asked whether they had experienced problems related to fatigue such as difficulty concentrating and staying alert, whether fatigue was a problem both in their industry and to them personally in their job, how often they become fatigued, at what time of day they experience fatigue, whether it affected their driving and in what ways. Overall, 195 (49%) respondents indicated fatigue was a major problem in their industry with 66 (34%) of those coming from the long-haul trucking sector. Out all responses received 298 (75%) indicate that fatigue is between a major and a substantial problem in their industry. This shows that the issue of fatigue is a considerable challenge.

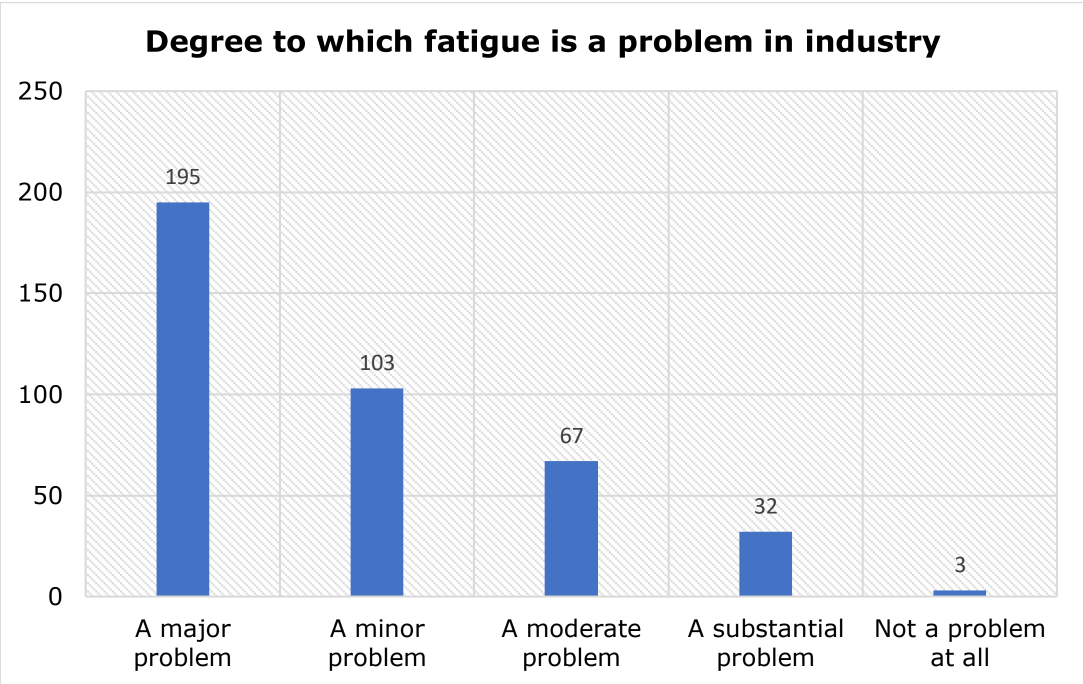


FIGURE 14 Degree to which fatigue is a problem in the industry (Source Author)

When asked whether they had experienced problems related to fatigue such as difficulty concentrating, staying alert, sustaining attention and being mentally slower, 59% reported that yes, they had experiences this, 36% reported that had experienced this somewhat and 6% reported that they had not. Of the 234 people that reported that yes, they had experienced fatigue related problems, 30% reported it was a major problem, 29% reported fatigue was a substantial problem to them personally, 34% reported it was a moderate problem, 7% reported it was a minor problem. Of the 144 (36%) people reported that they had somewhat experienced fatigue related problems, 16% reported fatigue was a major problem to them personally, 28% reported it was a substantial problem, 345 reported it was a moderate problem, 21% reported it was a minor problem and 1% reported it was not a problem at all.

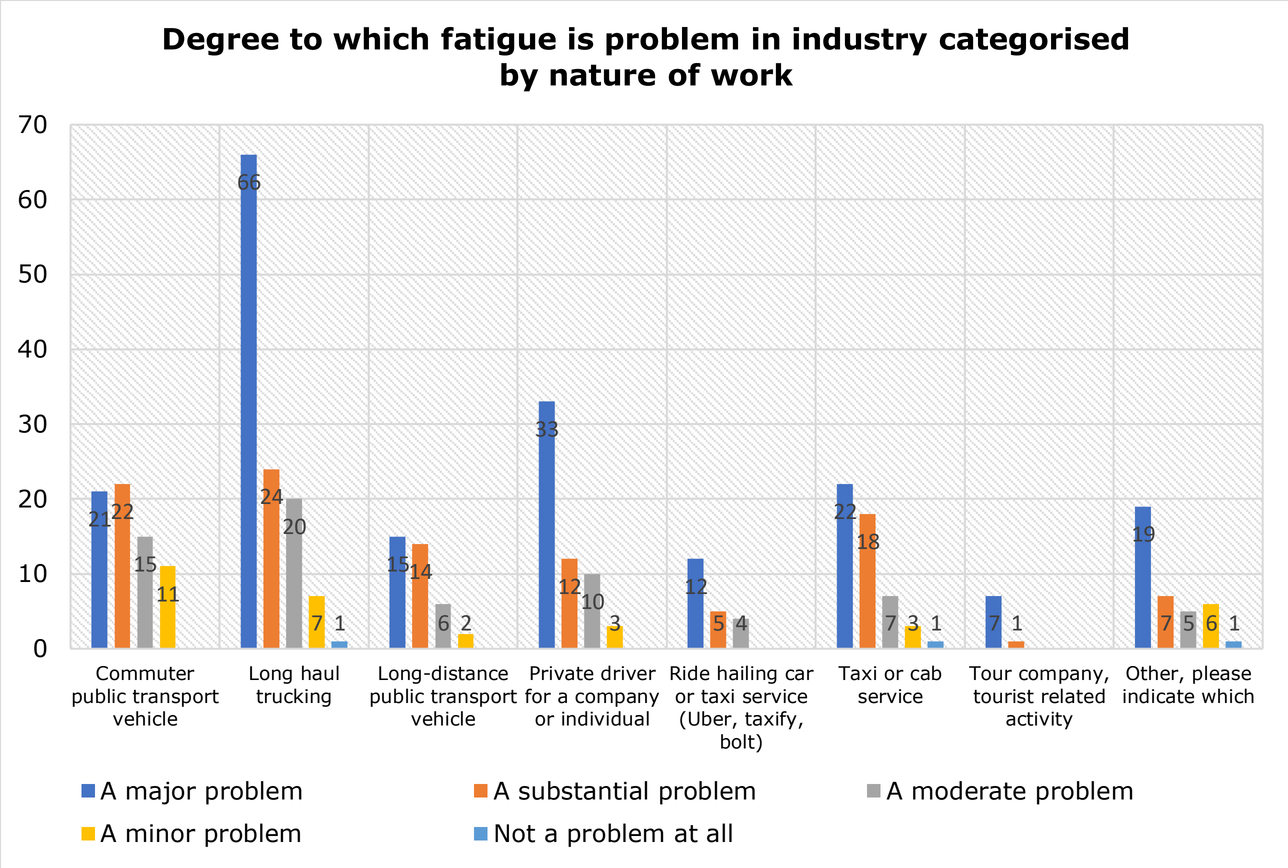


FIGURE 15 Degree to which fatigue is a problem in industry categorized by nature of work (Source: Author)

TABLE 5 Degree to which fatigue is a problem in industry among driver categories (n = 400) (Source: Author)

	n	A major problem	A substantial problem	A moderate problem	A minor problem	Not a problem at all	Total
Commuter public transport vehicle	69	30%	32%	22%	16%	0%	100%
Long haul trucking	118	56%	20%	17%	6%	1%	100%
Long distance public transport vehicle	37	41%	38%	16%	5%	0%	100%
Private driver for a company or individual	58	57%	21%	17%	5%	0.00%	100%

TABLE 5 Continued from previous page (n= 400) (Source: Author)

	n	A major problem	A substantial problem	A moderate problem	A minor problem	Not a problem at all	Total
Ride hailing car or taxi service (uber, taxify, bold)	21	57%	24%	19%	0%	0%	100%
Taxi or cab service	51	43%	35%	14%	6%	2%	100%
Tour company, tourist related activity	8	88%	13%	0%	0%	0%	100
Other	38	50%	18%	13%	16%	3%	100%

22 (6%) people reported they had not experienced problems related to fatigue. Of those 18% reported it was a major problem, 5% reported it was a substantial problem, 14% reported it was a moderate problem, 36% reported it was a minor problem and 27% reported it was not a problem at all.

TABLE 6 Percentage of driver responses to both degree to which fatigue is a problem personally, and self-reported experiences of fatigue (Source Author)

	A major problem	A substantial problem	A Moderate problem	A minor problem	Not a problem at all	Total
Yes	30%	29%	34%	7%	0%	100%
Somewhat	16%	28%	34%	21%	1%	100%
No	18%	5%	14%	36%	27%	100%

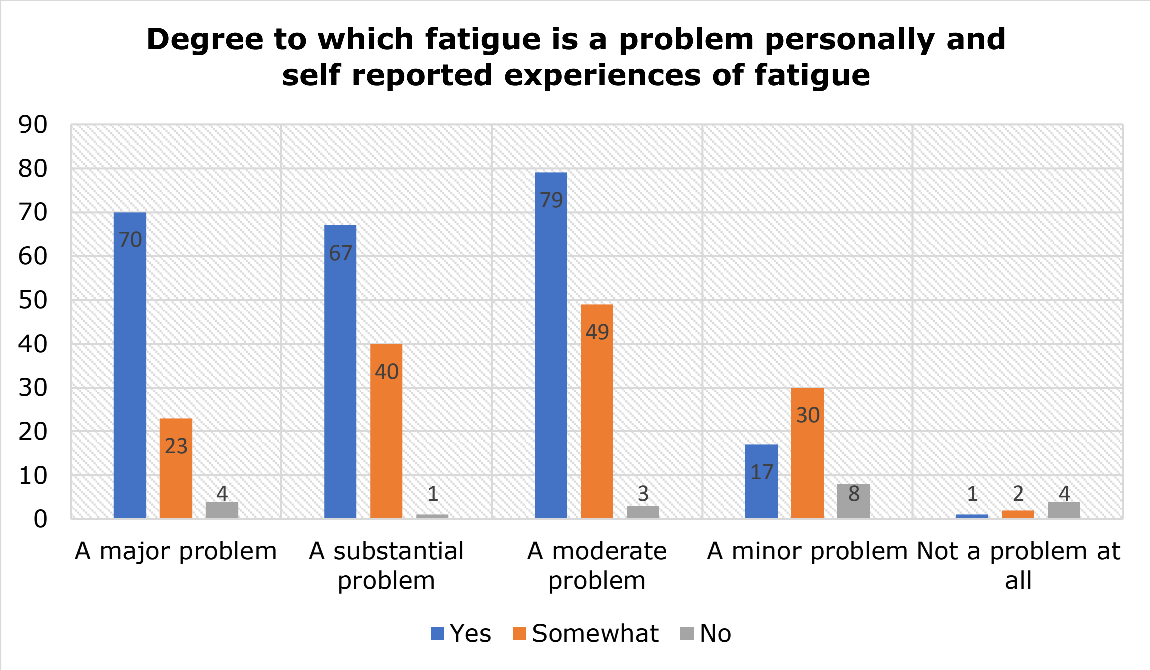


FIGURE 16 Degree to which fatigue is a problem to the driver, and self-reported experiences of fatigue (Source Author)

Looking at responses of how much of a problem fatigue is and frequency and frequency with which they report experiencing it, 68% of respondents who reported experiencing fatigue on every trip also reported it was a major problem, 19% reported it was a substantial problem, and 8% reported it was a moderate problem. 28% of respondents reported experiencing fatigue on most trips and 35% of those respondents reported it was a substantial and moderate problem respectively.

TABLE 7 Degree to which fatigue is a problem and how often respondents report experiencing fatigue (n = 400) (Source: Author)

	A major problem	A substantial problem	A moderate problem	A minor problem	Not a problem at all	Total
On every trip	25	2	3	7	-	37
	68%	19%	8%	5%	0%	100%
On most trips	33	1	40	39	-	113
	29%	35%	35%	1%	0%	100%
On about half your trips	9	6	37	13	-	65
	14%	20%	57%	9%	0%	100%
Occasionally	14	20	26	31	-	91
	15%	34%	29%	22%	0%	100%
Very rarely	16	26	25	18	9	94
	17%	19%	27%	28%	10%	100%

4.1.4. *Hours Respondents Experience Fatigue*
When asked which hours in the day they were likely to feel fatigued while working, 38% of respondents indicated 12 noon to 6pm, 17% reported between midnight and 6am, 36% reported between 6pm and midnight and 10% reported between 6am and 12 noon.

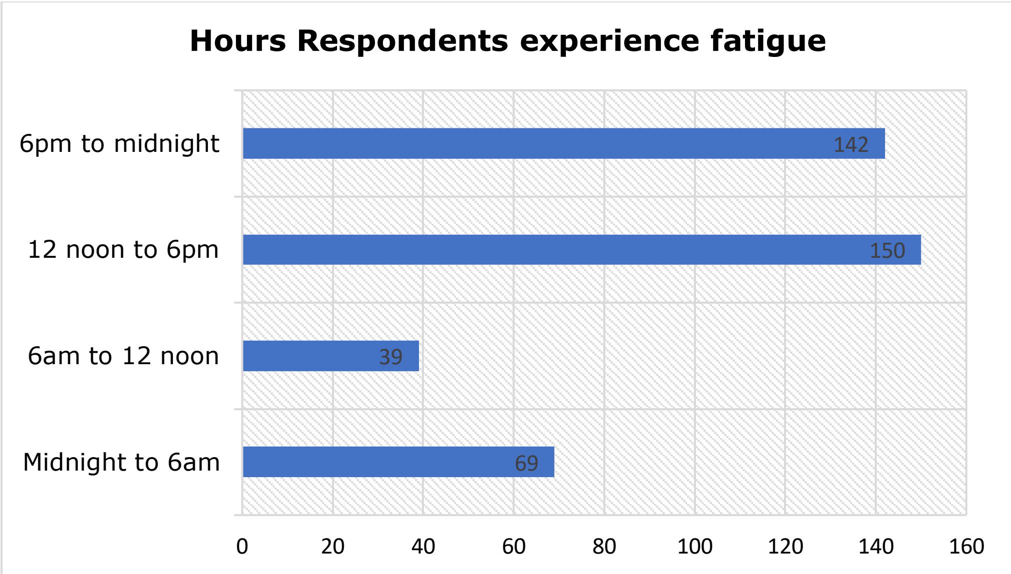


FIGURE 17 Hour's respondents reported they experienced fatigue (Source Author)

4.1.5. *Effects Of Fatigue on Driving*
Respondents were asked whether fatigue affected their driving. 45% of the 400 respondents indicated that yes it affected their driving. 51% of respondents indicated that it affected their driving somewhat while only 5% of respondents indicated that no it did not affect their driving. Respondents were also asked how frequently fatigue affected their driving. Due to a technical challenge with Qualtrics when setting up the survey this question was not displayed to all respondents.

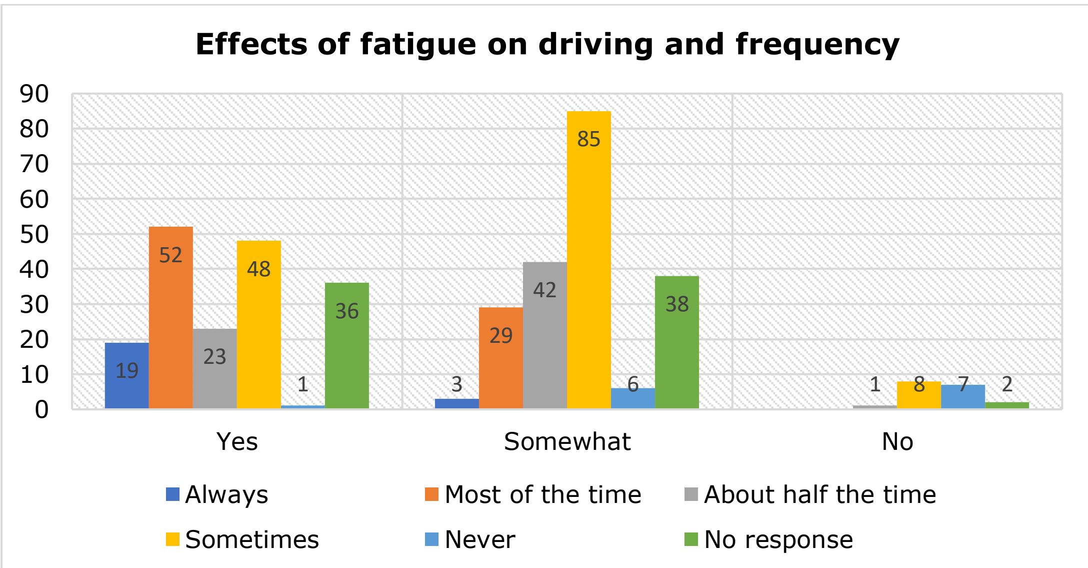


FIGURE 18 Effects of fatigue on driving and frequency with which it is experienced (Source: Author)

18 people responded no to the question of whether fatigue affected their driving. On the question of how often fatigue affected their driving majority of these respondents (44%) indicated that it sometimes affected their driving.

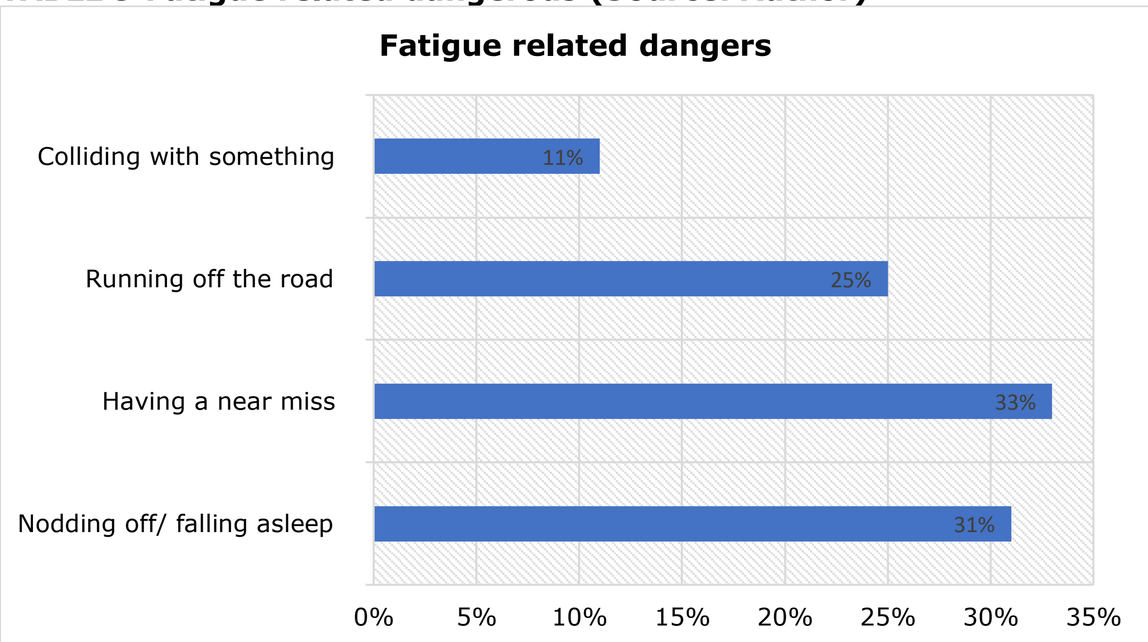
TABLE 8 Effects of fatigue on driving and frequency of the same (n = 400) (Source Author)

	Always	Most of the time	About half the time	Sometimes	Never	No response	Row Total
Yes	19	52	23	48	1	36	179
Percentage	11%	29%	13%	27%	1%	20%	100%
Somewhat	3	29	42	85	6	38	203
Percentage	1%	14%	21%	42%	3%	19%	100%
No	-	-	1	8	7	2	18
Percentage	0%	0%	6%	44%	39%	11%	100%

FIGURE 19 Effect of fatigue on driving

Respondents were asked in what ways fatigue affected their driving. They could select all responses that applied. 19% of the responses were that they were slower to react, 14% driving too slowly, 13% showed poorer awareness of other road users and 13% poorer gear changing, 11% poorer overtaking, 10% poorer attention to traffic signs, 9% poorer steering, 7% poorer breaking and 3% speeding.

TABLE 9 Fatigue related dangerous (Source: Author)



Respondents were asked whether they had experienced dangerous related to fatigue. They were asked to select all the responses that applied. 33% of responses indicated having a near miss, 31% of responses nodding off or falling asleep, 25% running off the road and 11% colliding with something.

4.1.6. *Factors Contributing to Fatigue*

Respondents were asked which factors contributed to their fatigue while driving. 23% of the responses to this question indicate that long driving hours contribute to fatigue. 15% show poor road condition, 16% inadequate sleep,12% poor vehicle condition, 10% heavy traffic, 9% poor diet/ irregular eating, 7% poor weather condition, 2% alcohol use 4% family problems and 2% aftereffects of stay awake drugs.

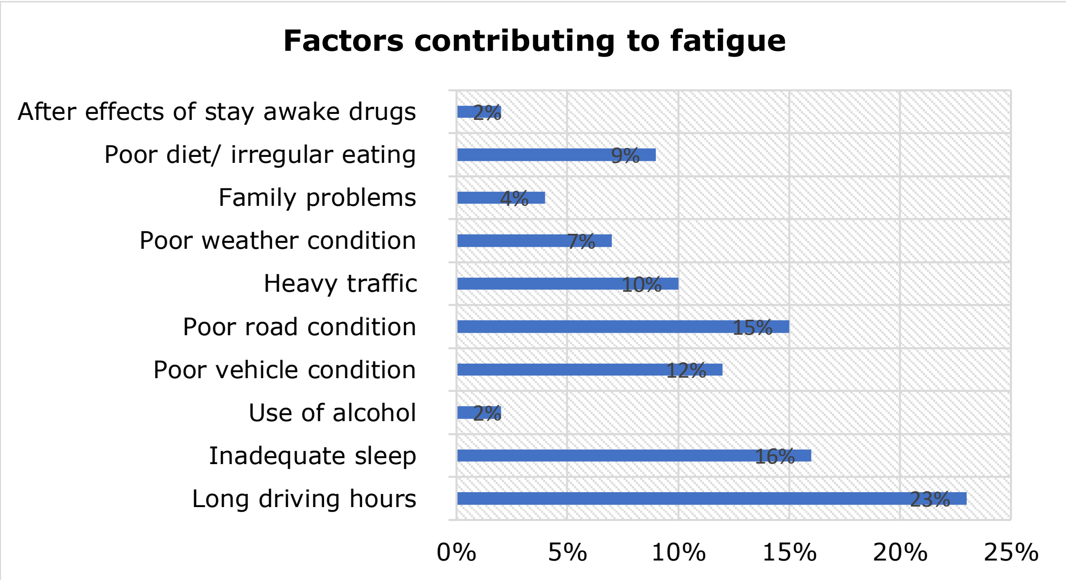


FIGURE 20 Factors contributing to fatigue (Source: Author)

4.1.7. *Fatigue Management*

Respondents were asked which strategies they use to manage feeling fatigued. Respondents were asked to select all strategies that they use. 19% of responses indicate they stop to rest, 14% indicate they adjust ventilation, 13% having a drink containing caffeine, 11% listening to music or the radio, 8% stopping to sleep, 8% taking a shower, 7% ignoring driving regulations to finish a trip when close to home, 5% stopping to eat among others as shown in figure 21.

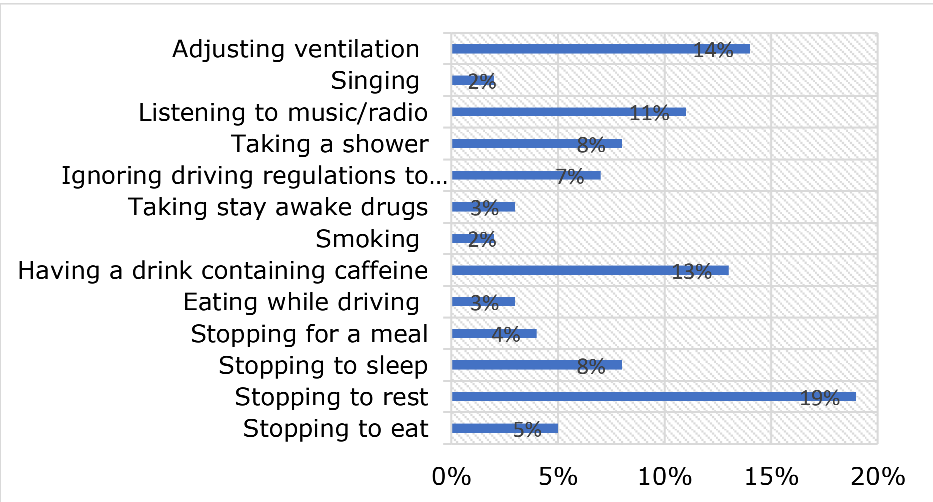


FIGURE 21 Personal strategies to manage fatigue (Source: Author)

Respondents were asked what employers should do to aid in managing fatigue. Respondents were asked to select all respondents they found relevant. 30% of responses indicated providing more information and training on fatigue management, 20% indicated efficient working conditions (e.g. quick loading in trucking, fixed departure times for transport, 12% indicated to offer regular and reasonable working schedule, 12% indicated to allow more time off between trips, 11% to increase pay, 7% to organize driving schedules to avoid night driving, 5% indicated use technology such as GPS to enforce working times and 3% indicated this was not relevant for them wither because they work independently or are not employed.

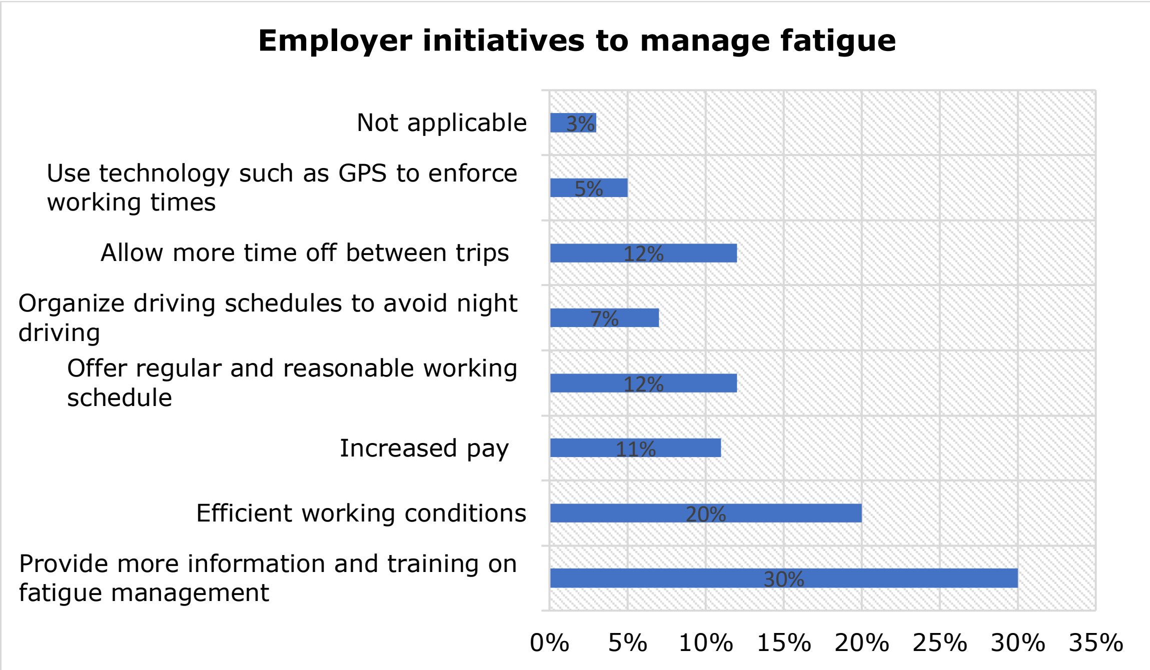


FIGURE 22 Employer initiatives of manage fatigue (Source: Author)

Respondents were asked about government initiatives that could aid in managing fatigue. Respondents were asked to select all the responses that applied. 20% of responses indicated government should provide more information and training on fatigue management, 16% indicated to improve roads, 12% to put in place stricter policing to prevent the use of stimulant drugs to stay awake, 11% to offer better off road facilities, 11% to set up policies to manage driving hours (e.g., shorter trip hours), 8% to introduce dedicated lanes for different traffic and others as shown in figure 23.

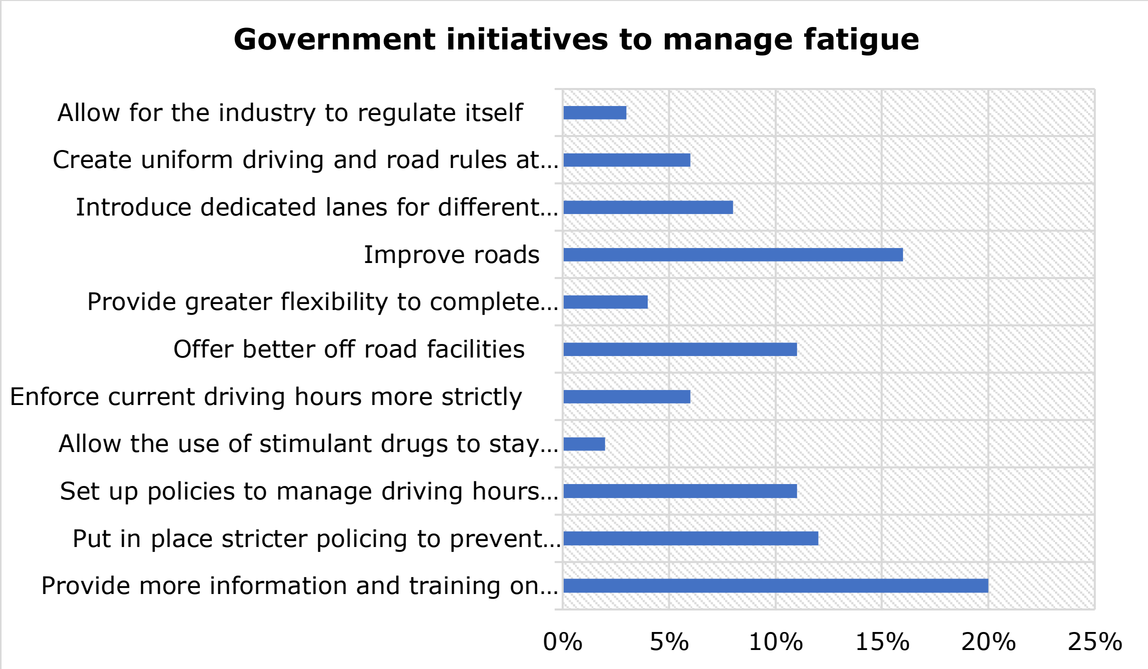


FIGURE 23 Government initiatives to manage fatigue (Source: Author)

4.1.8. *Working Against Driving or Work Regulations*

Respondents were asked how often they go against driving or work regulations by doing things such as working for longer periods that is permitted or taking more rest breaks. Due to a technical challenge in setting up the survey, this question was not displayed to all respondents. Of the 284 respondents who were displayed this question, 11% reported they go against driving regulations on every trip, 17% reported they do so on most trips, 9% reported occasionally and 44% reported they do so very rarely.

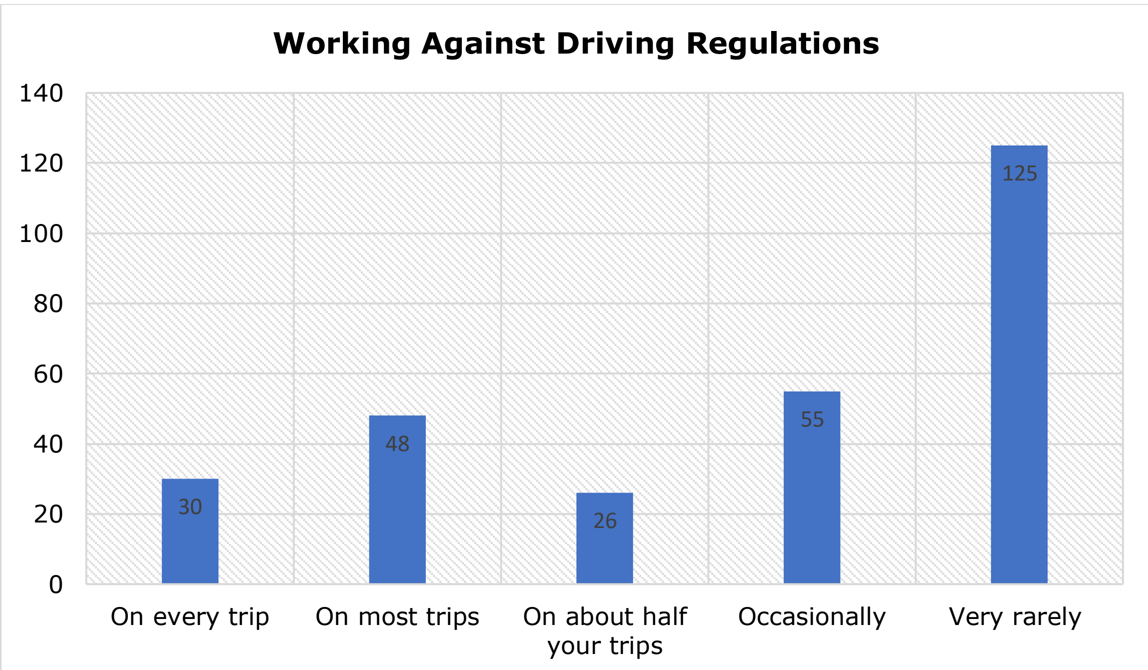


FIGURE 24 Frequency of working against driving regulations (Source Author)

TABLE 10 Frequency of working against driving regulations as a percentage (Source Author)

	On every trip	On most trip	On about half your trips	Occasionally	Very rarely
Percentage	11%	17%	9%	19%	44%

An element of interest in the study is whether professional drivers who reported driving against driving regulations also reported experiencing traffic crashes. Of the 284 respondents who answered the question of how frequently they drive against driver or work regulations 63 reported experiencing traffic crashes. Of those 29% reported they driver against set regulations on most trips, 25% reported doing so very rarely, 17% reported doing so occasionally. 13% on every trip and 10% on about half their trips.

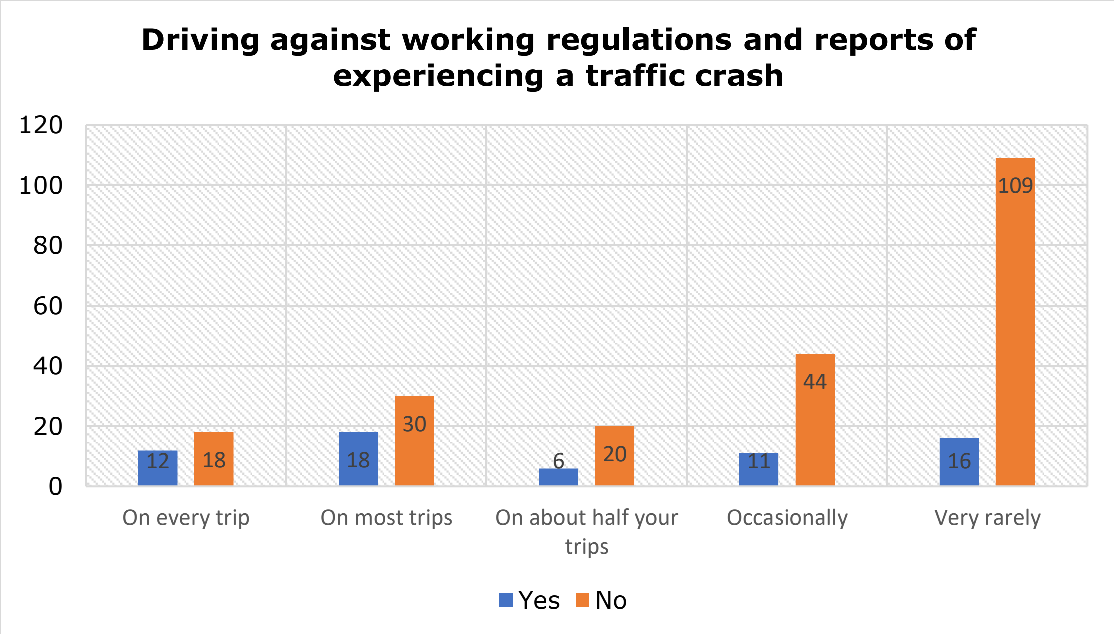


FIGURE 25 Driving against working regulations and reports of experiencing a traffic crash (Source: Author)

TABLE 11 Reports of driving against driving regulation and experiencing a traffic crash as a percentage (n = 284) (Source: Author)

	Yes	No	Total
On every trip	12	18	30
	40%	60%	100%
On most trips	18	30	48
	38%	63%	100%
On about half your trips	6	20	26
	23%	77%	100%
Occasionally	11	44	55
	20%	80%	100%
Very rarely	16	109	125
	13%	87%	100%

Professional drivers were in asked in the survey why they drive against work regulations. This question was open to all the responses that applied. 26% of responses indicate the reason was to return home, 23% indicate the reason was because of the respondent's tight schedule, 16% to get in early for the next load and to keep their job, 10% to do enough to earn a living and 4% for both because of rewards and penalties associated with arriving early and to reach adequate rest facilities. This question was not displayed to all respondents due to a technical challenge when setting up the survey.

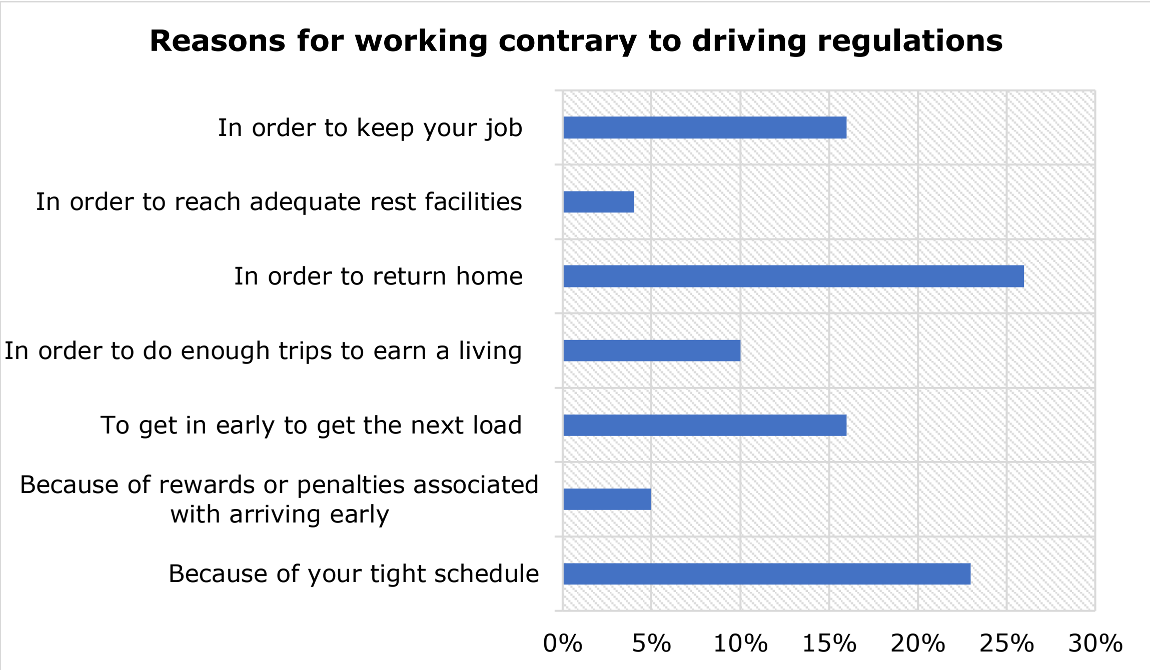


FIGURE 26 Reasons for driving against work regulations (Source: Author)

4.1.9. *Experienced a Traffic Crash Within the Previous 12 Months*

An important aspect of this study is to understand how fatigue is associated with self-reports of traffic crashes. To this end respondents were asked whether they had experienced a traffic crash in the previous 12 months. 76% of respondents reported that they had not. 7% of respondents reported that they had experienced a traffic crash.

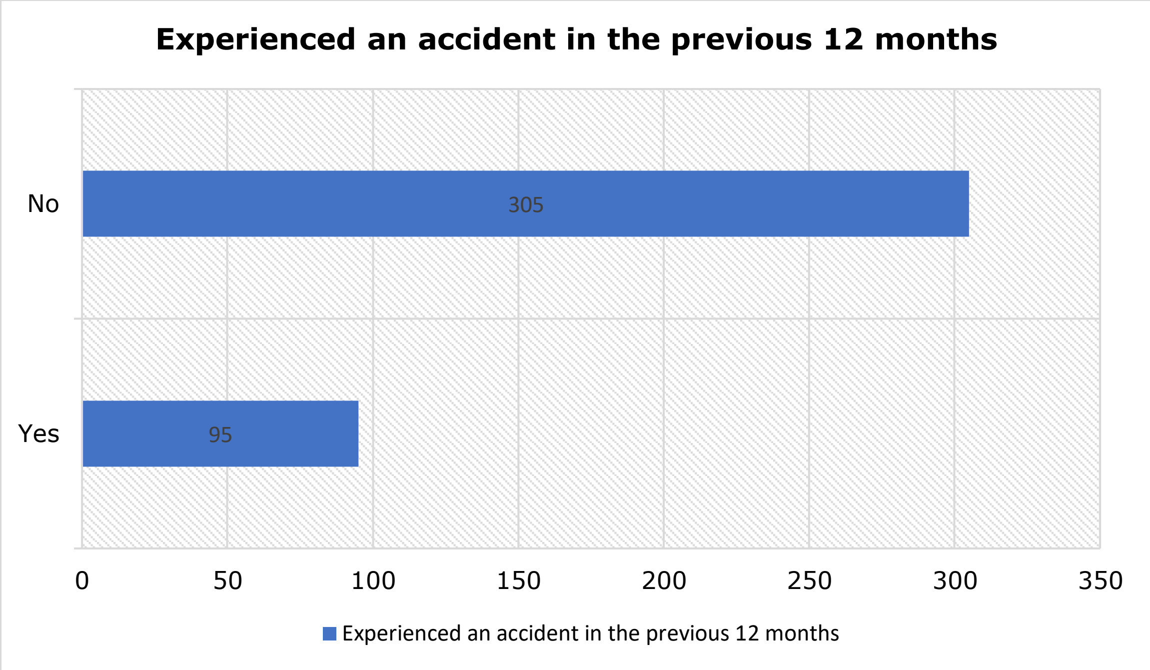


FIGURE 27 Experienced a traffic crash in the previous 12 months (Source: Author)

The respondents who reported they had experienced a traffic crash in the preceding 12 months were asked whether injury or property damage resulted from the traffic crash. 32% if responses indicated that there was injury or property damage resulting from the traffic crash. 68% of responses indicated that the traffic crash did not resulted in injury or property damage.

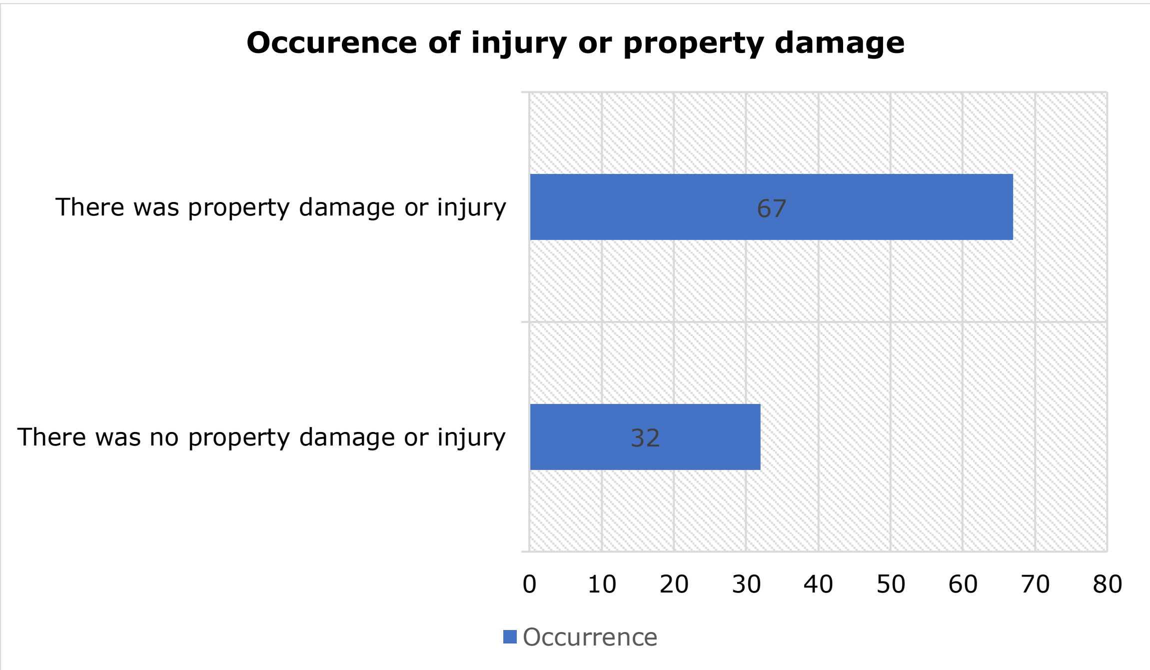


FIGURE 28 Occurrence of injury or property damage from a traffic crash (Source Author)

4.1.10. *Effect Of Fatigue and Age Groups*

Majority of respondents (70.75%) are between 25 and 44 years of age. It's of interest to determine which age groups reported that fatigue affected their driving. Of the respondents (179) who reported that yes fatigue affected their driving 67 (37%) are between 35 and 44 years of age. The second highest numbers are of people between 25 and 64 with 50 (28%) respondents. According to Zhang et al., (2016) younger drivers are more likely to report experiencing fatigue as they have less experience and need to concentrate more on their driving. Based on responses to this question there isn't a clear difference to indicate whether this is the case.

TABLE 12 Effect if fatigue and age group as percentages (Source: Author)

Age group	n	Yes	Somewhat	No	Total
18 – 24	17	53%	41%	6%	100%
25 – 34	126	40%	56%	5%	100%
35 – 44	157	43%	52%	5%	100%
45 – 54	80	51%	45%	4%	100%
Over 55	20	60%	40%	0%	100%

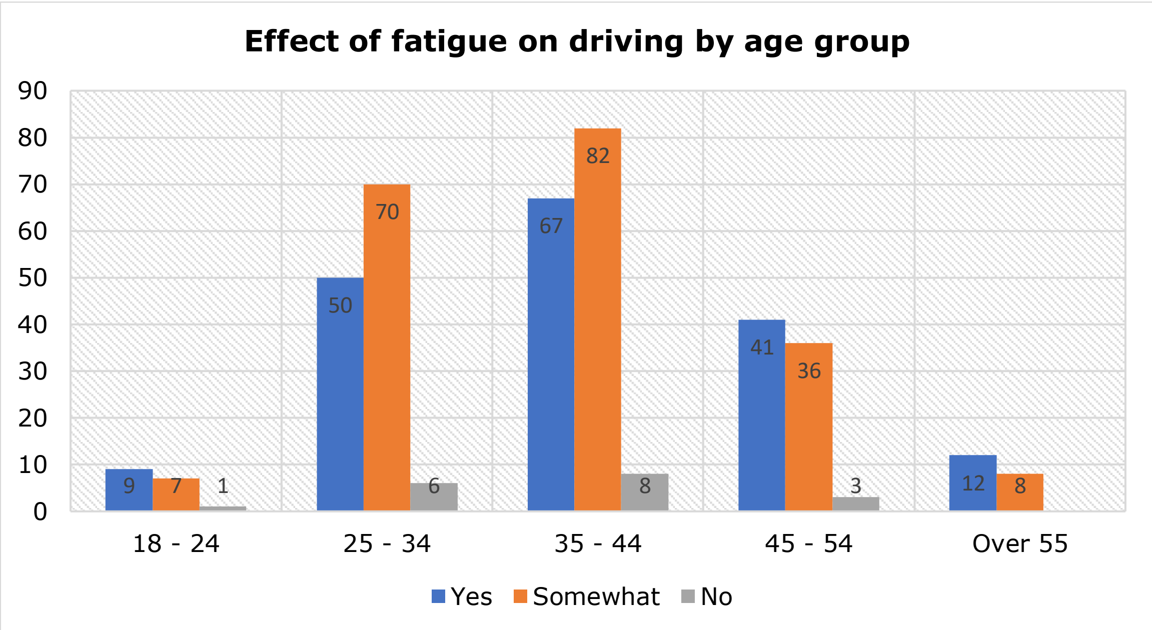


FIGURE 29 Effect of fatigue and age group (Source: Author)

4.2. Associative Factors for Traffic Crashes

4.2.1. Fatigue

One of the objectives of the study is to understand how frequency of experiencing fatigue affects self-reports of experiencing traffic crashes. Of the respondents (95) that reported experiencing a traffic crash in the preceding 12 months, 42% reported experiencing fatigue on most trips, 19% occasionally, 17% on about half their trips, 13% on every trip and 9% very rarely.

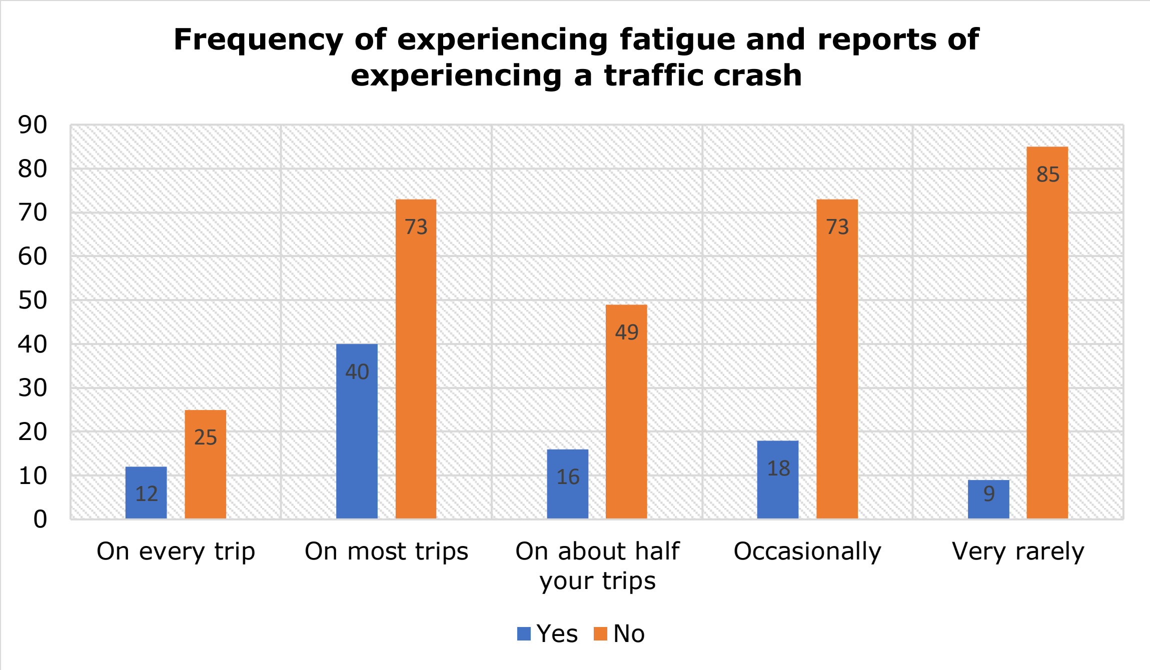


FIGURE 30 Frequency of experiencing fatigue and reports of experiencing a traffic crash (Source: Author)

Fatigue is a known risk factor for the occurrence of traffic crashes. A key objective of this study is to understand the association between fatigue and self-reports of experiencing a traffic crash. To determine this effect a Chi-square test was performed on frequency of experiencing fatigue and self-reports of traffic crashes.

TABLE 13 Cross tabulation of frequency of experiencing fatigue and reports of experiencing a traffic crash (n = 399) (Source: Author)

Frequency of experiencing fatigue	Yes	No	Row totals
On every trip	12 13%	25 8%	37 100%
On most trips	40 42%	73 24%	113 100%
On about half your trips	16 17%	4 16%	65 100%
Occasionally	18 19%	73 24%	91 100%
Very rarely	9 9%	85 28%	94 100%
Total	100%	100%	

TABLE 14 Chi-Square Table

	value	df	Asymptomatic significance (2-sided)
Pearson Chi-Square	20.668[a]	7	<0.001
Likelihood Ratio	22.201	7	<0.001
Linear-by-Linear Association	18.904	1	<0.001
N of Valid Cases	399		

0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.90.

The Pearson Chi-square value is equal to 20.668 on 7 degrees of freedom (p= .001) which is less than α= 0.05 that represents the significance level. The null hypothesis is rejected, and the alternative hypothesis adopted. Frequency with which professional drivers report experiencing fatigue has a significant effect on self-reports of experiencing of traffic crashes

TABLE 15 Symmetric Measures

		Value	Approximate significance
Nominal by nominal	Phi	0.228	<0.001
	Crammer's V	0.228	<0.001
N of Valid Cases		399	

To determine the size and significant of the effect symmetric measures are used. The value of Phi is 0.228 which shows the size of the effect is moderate. The P-value for the size of the effect is <0.001 which is less than α= 0.05 and theirfore significant.

Effect of Explanatory Variables on Reports of experiencing a traffic crash

Chi-square tests were carried out on explanatory variables age, gender, years of experience, days a week worked among others as such in table 16. The analysis was conducted to test the hypothesis whether the variables in question had a significant effect on reports of experiencing traffic crashes.

TABLE 16 Characteristics of respondents according to outcome of experiencing traffic crashes (Source: Author)

Characteristic		No traffic crash reported N (%)	Traffic crash reported N (%)	P-value [1]
Gender	Male	280 (76.1%)	88 (23.9%)	0.813
	Female	23 (74.2%)	8 (25.8%)	
Age	18 – 24	13 (72.2%)	5 (27.8%)	0.351
	25 – 34	90 (71.4%)	36 (28.6%)	
	35 – 44	118 (76.1)	37 (23.9%)	
	45 – 54	64 (80%)	16 (20%)	
	Over 55	18 (90%)	2 (10%)	
Nature of work	Commuter public transport vehicle	54 (78.3%)	15 (21.7%)	0.20
	Long-distance public transport vehicle	27 (71.1%)	11 (28.9%)	
	Long haul trucking	90 (76.3%)	28 (23.7%)	
	Private driver for a company or	44 (75.9%)	14 (24.1%)	
	Taxi or cab service	30 (58.8%)	21 (41.2%)	
	Ride hailing car or taxi service (Uber, taxify, bolt)	17 (81%)	4 (19%)	
	Tour company, tourist related activity	10 (100%)	0 (0%)	
	Other	31 (91.2%)	3 (8.8%)	
Years working as a driver	Less than 5 years	49 (16%)	15 (15.6)	0.304
	5 to 10 years	132 (43.6%)	50 (52.1%)	
	More than 10 years	122 (40.3%	31 (32.3%)	
Days a week worked	1 to 2	3 (75%)	1 (25%)	0.10
	3 to 4	40 (70.2%)	17 (29.8%)	
	5 to 6	180 (82.2%)	39 (17.8%)	
	7 days**	80 (67.2%)	39 (32.8%)	

[1] Pearson's Chi square of Fishers exact test p-values

TABLE 16 Continued from previous page (Source: Author)

Characteristic		No traffic crash reported N (%)	Traffic crash reported N (%)	P-value [2]
Hours a day worked	Less than 6 hours	9 (75%)	3 (25%)	<0.001
	6 to 12 hours	148 (87.1%)	22 (12.9%)	
	12 to 18 hours	132 (68.4%)	61 (31.6%)	
	More than 18 hours	14 (58.3%)	10 (41.7%)	
Description of work schedule	Determined by you	69 (70.4%)	29 (29.6%)	0.006
	Set by your employer and is predictable	144 (84.2%)	27 (15.8%)	
	Set by your employer, varies and is predictable	75 (67.6%)	36 (32.4%)	
	Set by your employer varies and is unpredictable	15 (78.9%)	4 (21.1%)	
What time of the day are you most likely to feel fatigued	Midnight to 6am	50 (73.5%)	18 (26.5%)	0.680
	6am to 12 noon	32 (78%)	9 (22%)	
	12 noon to 6pm	116 (78.9%)	31 (21.1%)	
	6pm to midnight	105 (73.4%)	38 (26.6%)	
How often do you work contrary to driving regulations	On every trip	18 (58.1%)	13 (41.9%)	<0.001
	On most trips	30 (62.5%)	18 (37.5%)	
	On about half your trips	20 (76.9%)	6 (23.1%)	
	Occasionally	45 (80.4%)	11 (19.6%)	
	Very rarely	107 (87.0%)	16 (13%)	

Gender, age, years working as a driver, days worked a week, time of day where fatigue is reported, nature of work and description of work schedule were

[2] Pearson's Chi square of Fishers exact test p-values

determined to not have a significant effect on self-reports of experiencing traffic crashes. The null hypothesis was adopted that they did not have a significant effect on self-reports of experiencing traffic crashes. Hours worked in a day has a significant effect on reports of traffic crashes with a Pearson Chi-square value of 21.596 (P= <0.001) and three degrees of freedom. The size of the effect is moderate with a Phi and Cramer's V value of 0.233 (P= <0.001). Frequency with which drivers work against driving regulation has a significant effect on reports of traffic crashes with a Person Chi-Square value of 19.509 (P= <0.001) and four degrees of freedom. The size of the effect is moderate with a Phi and Cramer's V value of 0.263 (P=< 0.001). The alternate hypothesis was accepted for that they did have a significant effect on self-reports of experiencing traffic crashes.

4.2.2. Predictive factors on reports of experiencing a traffic crash

Binary logistic regression analysis was used to model age, gender, years working as a driver, number of days worked, hours a day worked, description of work schedule, how often respondents reported experiencing fatigue as predictors of reports of experiencing traffic crashes in the preceding 12 months. The coding for reports of experiencing a traffic crash were yes = 1 and no = 0. The Omnibus Tests of model coefficient gave a Chi-square value of 54.239 with 20 degrees of freedom and p-value of <0.001. At a 5% significance level, the predictor variables used in the model explain the outcome variable better than would occur just by chance (Denis, 2018). The Hosmer and Lemeshow test had a chi-square value of 6.055 and a p value of 0.641 which is beyond the significance level and suggests the model is a good fit.

TABLE 17 Predictive factors on reports on experiencing a traffic crash in the preceding 12 months (n=399)

							95% C.I for EXP(B)	
	B	S. E	Wald	df	Sig.	Exp(B)	Lower	Upper
Gender Male	-0.476	0.484	0.966	1	0.326	0.621	0.240	1.605
Female								
Age group			3.962	4	0.411			
18 – 24	1.507	1.082	1.941	1	0.164	4.513	0.542	37.611
25 – 34	1.625	0.878	3.429	1	0.642	5.081	0.909	28.282
35 – 44	1.271	0.839	2.296	1	0.130	3.565	0.689	18.453
45 – 54	1.019	0.835	1.491	1	0.222	2.771	0.540	14.223
Over 55								
Years working as a driver			**0.018**	2	**.991**			
Less than 5	0.68	0.510	0.018	1	0.894	1.070	0.394	2.906
5 to 10	0.036	0.362	0.010	1	0.921	1.036	0.510	2.108
More than 10								
Number of days worked			**1.692**	3	**0.639**			
1 to 2	-0.617	1.288	0.230	1	0.632	0.539	0.043	6.739
3 to 4	0.125	0.407	0.093	1	0.760	1.133	10.510	2.517
5 to 6	-0.285	0.315	0.820	1	0.365	0.752	0.406	1.393
7 days								

TABLE 17 Continued from previous page (n=399)

							95% C.I for EXP(B)	
	B	S. E	Wald	df	Sig.	Exp(B)	Lower	Upper
Number of hours a day worked			**7.450**	3	**0.59**			
Less than 6 hours	-0.169	0.875	0.037	1	0.847	0.845	0.152	4.696
6 to 12 hours	-1.003	0.525	3.656	1	0.056	0.367	0.131	1.025
12 to 18 hours	-0.215	0.495	0.189	1	0.664	0.806	0.305	2.130
More than 18 hours								
Description of work schedule			**7.157**	3	**0.067**			
Determined by you	1.041	0.659	**2.495**	1	**0.114**	2.833	0.778	10.311
Set by your employer and is predictable	0.374	0.656	**0.325**	1	**0.569**	1.453	0.402	5.259
Set by your employer, varies and is predictable	1.043	0.655	**2.533**	1	**0.111**	2.837	0.786	10.246
Other								
How often do you become fatigued			**14.802**	4	**0.005**			
On every trip	1.678	0.546	**9.455**	1	**0.002**	5.353	1.837	15.596
On most trips	1.524	0.441	11.963	1	<0.001	4.590	1.935	10.884
On about half your trips	1.215	0.487	6.226	1	0.013	3.371	1..298	8.757
Occasionally	0.759	0.463	2.685	1	0.101	2.136	0.862	5.293
Very rarely								
Constant	-3.254	1.301	6.259	1	0.012	0.039		

From the binary logistic regression, age, gender, years working as a driver, number of days worked, number of hours a day worked, and description of work schedule are not significant predictors of reports of experiencing a traffic crash. How often one becomes fatigued with a p value = 0.005 is however a significant predictor of reports of experiencing a traffic crash with a significance level of 0.05.

The adjusted OR for gender shows that men have 37.9% lower odds than women of reporting experiencing a traffic crash. It should be noted that this result is affected by the relatively small sample of women compared to men. Respondents aged between 25 and 34 have 408.1% higher odds of experiencing a traffic crash compared to people over 55, followed by people aged between 18 and 24 with 351.3% higher odds than people aged over 55. This shows that younger drivers are more likely to report experiencing traffic crashes than their older counterparts. The adjusted OR shows that drivers with less than 5 years of experience have 7% higher odds than those with more than 15 years of experience of reporting a traffic crash. This shows that drivers with more experiences are less likely to report experiencing traffic crashes than their less experienced colleagues.

The adjusted odds ratio indicates that drivers working between 3 to 4 days have 13.3% higher odds of reporting a traffic crash that those working 7 days. However, drivers working 5 to 6 days have 24.8% lower odds of reporting experiencing traffic crashes compared to drivers working 7 days. Drivers working between 1 to 2 days have 95.7% lower odds of experiencing a traffic crash compared to those working 7 days.

The adjusted odds ratio indicates that the number of days worked shows that drivers working less than 6 hours have 15.3% lower odds of reporting traffic crashes compared to drivers operating for longer than 18 hours. Drivers working between 6 to 12 hours have 94.4% lower odds of experiencing traffic crashes compared to drivers operating for longer than 18 hours. Those working between 12 and 18 hours have 19.4% lower odds of experiencing a traffic crash. This shows that longer working hours are associated with increased traffic crash risk.

The adjusted odds ratio for determination of work schedule indicates that compared to drivers whose who selected other, those with the ability to determine their own schedule, operate on a predictable work schedule experience set by their employer, and operate on an unpredictable schedule set by their employer, have a reduced traffic crash risk. This is represented by adjusted odds ratio of 0.114 (88.6%) for those able to determine their work schedule, 0.569 (43.1%) for those whose work schedule is set by their employer and is predictable, 0.111 (88.9) for those whose work schedule is set by their employer varies and is unpredictable.

On the predictive variable of how often they become fatigued while driving, the adjusted odds ratio for those who reported experiencing fatigue on every trip, have 5.353 (435.3%) higher odds of experiencing a traffic crash compared to people who reported experiencing fatigue very rarely. Those who reported experiencing fatigue on most trips have 4.590 (359%) higher odds than people who reported experiencing fatigue very rarely of experiencing a traffic crash. For drivers who experience fatigue on about half their trips have 3.371 (237.1%) increased odds of reporting a traffic crash compared to those who very rarely experience fatigue. For those who reported experiencing fatigue occasionally the increased risk is 2.136 (113.6%). This indicates that drivers who experience fatigue more frequently are at an increased risk of experiencing traffic crashes compared to those who experience it very rarely.

5. DISCUSSION

This study sought to understand fatigue as a cause of traffic crashes among professional drivers in East Africa. This chapter discuss the results of the study.

5.1. Fatigue

Fatigue is a major issue affecting professional drivers (Liu et al., 2019). Professional drivers work long hours, spend a lot of time alone and perform repetitive monotonous activities all of which lends itself to causing fatigue (Taylor & Dorn,2006; Frone & Tidwell, 2015). The results of the study showed that fatigue is indeed a significant problem with 91% of responses to this question, indicating that fatigue was between a major and a moderate problem in their industry. Fatigue is an issue across industries. In 5 of the 8 categories provided for sectors show more than 50% of respondents per sector indicated fatigue was a major problem in their industries. 56% of respondents in the long-haul trucking sector reported that fatigue was a major problem, 57% of drivers in both the ride haling and private driver sector reported the same.

Drivers experiencing fatigue have been found to have reduced arousal and poor vehicle control. They experience near misses with traffic crashes (Matthews et al., 2012). Studies in PC based York Driving Simulator showed that extended periods of wakefulness led to an increase in speed deviation, lane drifting and off road incidence (Baulk et al., 2008). These aberrant driving behaviours could very well lead to a traffic crash. On the question of how fatigue affects their driving of responses indicated by reacting slower, driving slowly and poor awareness of other traffic or road users. Respondents reported they had experienced fatigue related dangers such as having a near miss, nodding off or falling asleep, running off the road and colliding with something. This is consistent with expected effects of fatigue based on literature. Effects of fatigue as described here pose a traffic crash risk which can results in death, serious injury, destruction of property among others.

Long working hours and inadequate sleep is known to cause impairment. Some studies put 24 hours of wakefulness at the same impairment level as 0.10% BAC. The permissible BAC in some regions is 0.08% (Dawson et al., 2021). Liu et al., (2019) found that insufficient sleep affects driving performance. This effect was seen after 8 hours of driving in a given shift. Respondents indicated that long driving hours, poor driving condition and inadequate sleep contributed to their fatigue. Extended periods of wakefulness or activity is known to lead to mental and physical fatigue (Frone & Tidwell, 2015). Lack of adequate sleep causes a marked effect on driver performance. Drivers who do not get adequate sleep have been found to take more breaks 8 hours into driving compared to drivers who get enough sleep. These breaks do not reduce the risk associated with impaired driving and continued driving only increases the risk. In order to perform optimally drivers need to have had adequate sleep before beginning their shift (Liu et al., 2019).

Based on circadian rhythms people experience an "alertness dip" early in the afternoon which correlates to a feeling of being sleepier. These periods of alertness dip correspond to increased reports of sleep related crashes occurring between 2:00 am and 6:00 am and 2:00 pm and 4:00pm (May & Baldwin, 2009). Drivers were asked during which time window they experience fatigue. With 38% of respondents indicating they experience fatigue in the 6-hour window between 12 noon and 6pm. It is consistent with what is known based on literature. It's interesting to note that the second time window selected is between 6pm and midnight with 36% of respondents whereas the expected second highest time would be the hours between midnight and 6:00am. The level of fatigue one may experience follows a circadian rhythm in 24-hour cycles. It is affected by sleep and wakeful periods prior to the time in question (Dawson et al., 2014). With 36% of respondents indicating they experience fatigue between 6:00pm and midnight may be explained by different operating hours professional drivers in the region operate on. For example, some public transport operators have 24 hour operating licence and they operating hours may affect the time they report experiencing fatigue (Wanambisi, 2018).

Work schedule

Professional drivers are often inundated with work pressures to arrive at their destination on time or to conduct a certain number of trips to make enough money. These pressures mean long hours as shown by this study. Long working hours under poor conditions puts professional drivers at high risk for health complications (Wang et al., 2019; Behrens et al., 2017; Vries et al., 2020). Professional drivers are faced with increased risk linked to the road traffic environment sue to long distances they travel and the relatively longer periods they spend on the road (Chen et al., 2021). Performance outcomes deteriorate the longer one is awake. Long periods of wakefulness correspond to decreased performance (May & Baldwin, 2009). Long working hours also leads to driver impairment which has been seen both through on-road studies and simulator studies (Baulk et al., 2008).

From the questionnaires, 85% of respondents work 5 or more days a week and 97% work on average more than 6 hours a day. These long working hours are characteristic of this line of work. Professional drivers tend to work irregular schedules and for long periods of time. Long working hours consume both mental and physical energetic resources which leads to fatigue (Matthews et al., 2012). Short sleep durations are associated with increased car crash risk. The recommended sleep duration for people older than 18 years is between 7 to 8 hours. Sleep durations of between 6 hours up to 11 hours may be appropriate for some people. Sleep durations of less than 6 hours and less than 5 hours for people older than 65 years are not recommended (Hirshkowitz et al., 2015).

Previous studies have shown that sleeping for less than 5 hours in the preceding 24 hour period is the threshold for increased crash risk (Williamson et al., 2011). Other studies have shown that the traffic crash risk within the first 4 hours of driving is low but that the risk increases by 50% after three hours and to between 80% and 130% in the last hour (Zhang et al., 2020). The demands of the job faced by professional drivers puts them at increased risk both for traffic crashes as well as other medical conditions. With 54% of respondents indicating they work more than 12 hours; their sleep duration can be assumed to be limited.

Other risks associated with long working hours includes lost productivity, high employee turnover and increased cost of healthcare (Matthews et al., 2012). The Japanese term "Karoshi: reefers to "death or disorder by overwork-related cerebrovascular/cardiovascular diseases (CCVDs)" (Kubo et al., 2021, p.1). In a previous study (n=203) of victims of Karoshi, more than two-thirds worked more than 60 hours per week. This study linked long working hours as a major risk factor for Karoshi related deaths. Long working hours has also been linked to increased risk of stroke (Kubo et al., 2021).

Managing Fatigue

Chen et al., (2021) indicated drivers can self-regulate their fatigue levels by identifying it when it occurs and take action to accommodate the associated impairments while driving. This could take the form of reducing traveling speed when one feels fatigued to mitigate the traffic crash risk (Meng et al., 2015). The use of caffeinated drinks, taking a break, changing tasks, and monitoring psychophysiological markers for loss of alertness and sleepiness are popular fatigue management measures. Changing in-vehicle design systems can be used to deter boredom in drivers. Actively engaging drivers and maintaining their interest keeps them alert while doing tedious repetitive actions such as driving (Matthews et al., 2012).

Adequate sleep and rest in between consecutive working periods have been found to be effective fatigue relieving measures both in simulators and in the field. Adequate sleep before driving and taking breaks while driving allows the driver to recover from the effects of fatigue (Zhang et al., 2020). Training drivers can also be used to promote adaptive coping skills. This training is personalised for the drivers where they are given scenarios related to their work and they assess outcomes that may arise. Drivers can learn about strategies they can deploy to recover from fatigue (Matthews et al., 2012). On how employers can help employees manage fatigue, professional drivers feel employers should provide more information about training on fatigue management, provide efficient working conditions, allow for more time between trips and offer regular and reasonable working schedule.

In-vehicle warning devices that monitor eye movements can provide drivers with useful warning mechanism for their level of alertness. These devices allow the driver to assess their danger level and respond to mitigate their fatigue levels (Matthews et al., 2012). However, overreliance on these warning systems present a danger. Drivers may continue driving even while feeling fatigued and subsume their own judgement in favour of that determined by the warning system (Zhang et al., 2016). Adaptive intelligent cruise control and automated highway systems are other forms of in-vehicle technology used to relieve drivers of the task demand related to driving. These technologies however may led to poorer performance by reducing the engagement the driver has on the task and reduced situational awareness (Matthews et al., 2012).

To manage the risk of traffic crashes resulting from fatigue countries have taken measures like implementing set driving hour regulations. These regulations mandate rest breaks while driving and the maximum time on-duty. It’s important to note the specific regulations differ from country to country (Zhang et al., 2020). Road design is an important element in fatigue management. The use of rumble strips allows for monitoring alerting drivers weaving on the road. Rumble strips are an audio-tactile device that produces vibration and noise when the wheels of a car driver over it (May & Baldwin, 2009). It can be placed at the centreline or on the edge line (Zhang et al., 2016). It serves to warn drivers when they have crossed it and to correct their driving direction (May & Baldwin, 2009).

Working against driving regulations
Professional drivers work ferrying people and goods. They face pressures to meet route timetables, deliver on time, are often in traffic jams and travel long distances (Phillips, 2014). It's not surprising that they would work against set regulations while facing this kind of pressure. Working regulations typically have people e.g., work for a certain duration or offer set rest break. Respondents were asked whether they worked against driving regulations and the cause of the behaviour. It's important to note that in a self-reported questionnaire maybe subject to bias where the driver may not wish to disclose issues like working against regulation out of fear of consequences (Baulk et al., 2008).

Modifying behaviour should be done under an evidence-based framework such as the behaviour change wheel and the COM-B model. Developing intervention policies that target behaviour requires that the behaviour and it's interacting factors are known and understood. COM-B posits that the source of a behaviour is linked to motivation, opportunity, and capability. To select an intervention to use, one must first understand what needs to change in these elements (Michie et al., 2014). When asked why drivers went against driving regulations, reasons provided include to return home, because of tight schedule and to keep their job. Many professional driver income schemes incentivise them to work against driving regulations. In the public transport sector, it is a feature of the industry that they disregard traffic rules such as speed to complete journeys in order to take on the next round of customers (Phoebe, 2017).

5.2. Associative Factors for Traffic Crashes

Fatigue is generally accepted to be a major risk factor for the occurrence of traffic crashes (Williamson et al., 2011). Fatigue affects performance and is linked with decreased task capability (Phillips, 2014). The effect of frequency of experiencing fatigue on reports of experiencing a traffic crashes was assessed using Chi-square test. The test showed that frequency of experiencing fatigue had a significant effect on reports of experiencing a traffic crash ($P=<0.001$) and that the effect was moderate. Professional drivers work long hours which leads to irregular sleep patterns and fatigue. The negative effects of fatigue such as decreased cognitive performance is associated with reduced decision-making capabilities and vigilance. This impairs a drivers ability to make corrections such as position of the vehicle on the road and their ability to appropriately respond to changing driving conditions (Longman et al., 2021).

The demands of the job for professional drivers requires sustained high task demands. It is not surprising that continued exposure to fatigue has a significant effect on traffic crash risk. In binary logistic regression analysis, frequency of experiencing fatigue was assessed as a predictive variable for self-reports of experiencing traffic crashes alongside gender, age, years working as a driver, number of days worked, number of hours worked and determination of work schedule. Drivers who reported experiencing fatigue on every trip had 5.353 (435.3%) higher odds of self-reports of a traffic crash compared to those who reported experiencing traffic crashes very rarely. This shows that increased exposure to fatigue increases traffic crash risk. Working longer hours is linked to irregular sleep patterns which is associated to fatigue which is a known contributing factor to occurrence of traffic crashes (Longman et al., 2021).

5.3. Limitations and Areas for Further Research

As with any study there are limitations to this research. Limitations to this study are:

- The study did not collect information on medical conditions of respondents in data collection. Fatigue can be caused by medical conditions such as sleep apnoea (Williamson et al., 2011; Ogunleye-Adetona & Felix, 2016). Further research on fatigue in the research area could investigate the effect of such conditions on fatigue among professional drivers in the East African setting. A recent study found that drivers with sleep apnoea have a 29% increased risk of being involved in a traffic crash while those with insomnia have a 33% increased risk (Bharadwaj et al., 2021).
- Available road crash data is incomplete or missing with regards to crashes caused by fatigue making it difficult to fully understand the scope of the problem (Zhang et al., 2016). This study contributed to the understanding of fatigue and its effects on professional drivers.
- Data collection was done using online questionnaires which required the respondent to have access to a smartphone or computer and the internet. In the times of COVID-19, in person data collection is a challenge. Studies conducted once the pandemic has passed can investigate using other means such as handwritten surveys to access a greater cross-section of professional drivers.
- Self-reported driver behaviour may be subject inaccuracy as the respondent may not wish to disclose experiencing fatigue or driving against road rules and regulation (Zhang et al., 2016). The respondent instructions addressed this concern by clarifying that the collected information would not be associated to the respondent to encourage them to be forthcoming.
- Self-reports of fatigue may be affected by recall bias (Williamson et al., 2011). Future studies can specify a period for which the experiences of fatigue are being studies e.g., the previous 30 days.
- Adequate data from Rwanda, Burundi and South Sudan was not obtained which means the results of the study may not be inferred to apply to professional drivers operating in these regions. Data collection was affected by the COVID-19 pandemic and the research area was redefined several times. Further research can focus more closely on these countries to create a better picture of the effects of fatigue on professional drivers operating there.
- Certain questions were not displayed to some respondents due to a technical challenge when setting up the survey and thus their answers for these questions are not available. The responses received for those affected were used in the analysis. The issue was corrected, and subsequent respondents had these questions displayed.
- Traffic crashes occur due to a confluence of factors which include condition of the driver, the actions of other road users, road condition and weather. It is difficult to identify the contribution of any one factor (Stern et al., 2019). This study did not collect data on other factors that may have been at play when the traffic crash occurred. Additional research into the effects of fatigue can include these factors to determine their effect.
- Demographic factors such as medication use, sleep history, opportunity to sleep and marital and family status were not considered. The age and history of maintenance of the vehicle is use is also an important variable to consider when studying crash risk. It includes the kind of technology the vehicle is equipped with as well as the brake and tyre quality (Stern et al.,

2019). Organizational factors such as the safety culture within the organization is an important aspect to consider, and further studies can take it into account (Mamo et al., 2014).

- The behaviour change wheel offers a systematic evidence based framework for understanding behaviour and designing interventions (Michie et al., 2014). This study did not use the behaviour change wheel toolkit to explore the behavioural aspects of fatigue driving. Additional studies in this area can use such procedures to explore the behavioural aspects associated fatigue driving.

5.4. Recommendations

Driver fatigue can be addressed in several ways. Recommendations to policy and decision makers are proposed below.

Engineering based countermeasures can be used to address fatigue. Road environment and condition are known to impact fatigue. Changes to the road environment such as from simple to complex negatively affects fatigue (Zhang et al., 2016). "Highway hypnosis" is a term used to describe a state of awareness drivers fall into when driving on road environments which are monotonous. After driving on a monotonous road for several hours, drivers lose alertness which puts the driver at risk of falling asleep (Matthews et al., 2012). Previous studies using a simulator have shown that monotonous driving conditions are associated with poorer performance demonstrated by over corrections (May & Baldwin, 2009). Drowsiness can be mitigated by the installation of centre and edge-line rumble strips to warn drivers when they are departing their lane or leaving the roadway. This measure has been found to be effective (Bharadwaj et al., 2021). Governments and local authorities are encouraged to install these measures particularly, on long stetches of road with monotonous environments (Zhang et al., 2016).

To tackle the issue of traffic crashes it is important that evidence-based solutions are implemented, and their effectiveness measured to determine whether they are successful. Previously, following very public traffic crashes with high fatalities, the government of Kenya banned nigh time travel of long-distance passenger vehicles in hopes of reducing the number of traffic crashes (*Kenya Bans Night Travel in the Wake of Fatal Accidents - Xinhua | English.News.Cn*, 2018). These measures were short lived, and their success is not clear. When this occurred in 2018, the ban was fought in court and the order suspended by the high court (Redazione, 2018). In a compromise the ban was lifted for operators with good safety records (Wanambisi, 2018). Reactionary measures like this are all too familiar. Punitive measures to address road safety assume that driver error is caused by lack of discipline or bad attitudes. This incorrectly categorises the cause of traffic crashes and countermeasures based on this assessment may not be effective (Boateng, 2021).

Government regulation is a powerful tool that can be used to address road safety issues through policies and regulations. It is however not the only means. Private sector involvement in the professional driver sector can provide self-regulation in and improvement on driver health and safety. In the public transport sector, there is frequent disregard for comfort and safety of passengers a condition which many passengers are unhappy with (Phoebe, 2017). Several start-ups have entered the market in the region which could offer a road map for how this kind of self-regulation could operate. In Uganda, a start-up called easy matatu offers passengers “reliable, safe and clean public transport”. They provide an online booking platform where passengers can reserve a seat in a matatu targeted for rush hour periods. The company identifies drivers, takes them through road safety education training and inspects their vehicles for safety. Vehicles on their platform are scheduled which assures customers of a seat at a given time (*About - Easy Matatu*, n.d.). In Kenya, a company called Swvl is offering similar services with scheduled short and long-distance public transport services (*Swvl | Book Your Daily Ride or Make Money Driving Now*, n.d.). Increased involvement of private sector players will encourage this kind of competition for safety and would improve the operations of the industry. This form of increased private sector involvement is also present in the logistics sector with entry of e-logistics players with start-ups like Lori, sendy and amitruck *(Logistics Tech Startups in Kenya | Tracxn, n.d.)*

Improvement of traffic safety culture within an organization has positive impacts on occupational health and safety. The perception of traffic safety culture within an organization has been linked to traffic safety outcomes (Mamo et al., 2014). Organizations actions should be consistent with the policies they espouse. For example, to demonstrate that safety is a key priority of an organization, managers should not place undue demands on drivers which would require them to break driving regulations such as speeding and driving longer that is prescribed. Where there is a gap between the set policies and activities, drivers may conclude that safety is not an organization priority (Rispler & Luria, 2021). Rispler & Luria (2021) concluded that organizational staff are more likely to modify their behaviour if the organization encourages them to do so in a genuine way. That is for the policies and actions to match. Organizations should for example, regulate work schedules in a predictable manner to allow for professional drivers to plan adequate sleep around their work schedules. As much as possible this work schedule to adapt to the 24-hour circadian rhythms to allow for adequate recuperative rest. Organizations can also conduct training of fatigue detection and offer effective coping strategies.

Organizations should develop comprehensive crash recording checklist. This can be paper based or computerised although computerised system is recommended. The checklist should include aspects that influence the crash such as time since last shift of the associated driver, duration into the trip when the crash occurred, location of crash, time and date of crash, demographic factors about the driver (e.g., age, marital status, years of experience), alcohol and drug involvement and sleep history of the driver. Other data points that should be captured are maintenance history of the vehicle, weather conditions at the time of the traffic crash, and whether other road users were involved. The outcome of the traffic crash is also important. Injury, death, and property destruction that resulted should also be recorded. A comprehensive record like this would allow an organization to better map out the aspects that contribute to a traffic crash and devise strategies to address them.

6. CONCLUSION

Fatigue is a complex phenomenon caused by several factors such as lack of adequate sleep, monotonous driving tasks, side-effects of medication, task demands related to driving among other factors (Zhou et al., 2021). Fatigue is a well-known risk factor for traffic crashes (May & Baldwin, 2009). Fatigue causes one to respond slower, be less attentive or respond inappropriately which may lead to a traffic crash. Professional drivers are at high risk of experiencing traffic crashes as they spend long hours on the road and are predisposed to chronic health conditions due to risky behaviours and occupational factors related to their work (Williamson et al., 2011). This study sought to understand how fatigue affects professional drivers in East Africa by conducting literature review and surveying professional drivers.

Based on the results of the study fatigue indeed has a significant effect on the occurrence of traffic crashes. Binary logistic regression analysis of predictive factors for self-reports of experiencing traffic crashes showed that frequency of experiencing fatigue was a significant factor. Working against driving regulations and number of hours worked a day were also found to have a significant effect on reports of experiencing a traffic crash in Chi-Square test. Professional drivers disregard traffic rules due to work and time pressures to arrive home early and out of fear of losing their job. Financial and work pressures are understood to be key motivating factors for this behaviour (Lalla-Edward et al., 2016, Matthews et al., 2012; Taylor & Dorn, 2006).

Recommended measures to address fatigue include increased involvement of private sector in public transport operations and logistics, infrastructural interventions to improve road conditions, improvement of organizational safety culture and development of traffic crash checklist of information to be collected by organizations about traffic crashes. Future research can investigate the impact of medical conditions, additional demographic factors not considered for this study as well as apply a behavioural intervention framework in the design of interventions.

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8. ANNEXES

8.1. Survey

Title of Research: **Understanding Fatigue as a cause of work-related traffic crashes among professional drivers in East Africa.**
Dear respondent, I am a master’s student in the Transportation Sciences program at Hasselt University. I am conducting this research on fatigue driving as a cause of work-related traffic crashes for my master's thesis. My promoters are Prof. Dr Kris Brijs and Dr Veerle Ross.

This questionnaire contains four sections
Section 1: Limited socio-demographic information relevant to my study
Section 2: Questions on fatigue and how it affects your driving experience.
Section 3: Driver behaviour
Section 4: Brief questions to indicate whether you have experienced a traffic crash in the last 12 months.

This research aims to understand your experience and perspective. There are no wrong answers, only your personal opinions count. Some questions require yes or no answers. You will also encounter statements or questions accompanied by a 5-point scale. For these questions, please select the option that is closest to your opinion regarding the statement.
Below is an example of a question you will encounter in the survey.

12.	How much of a problem do you think fatigue is in your industry?				
	1 A major problem	2 A substantial problem	3 A moderate problem	4 A minor problem	5 Not a problem
	○	○	○	√	○

Title of research: Understanding Fatigue Driving as a cause of work-related traffic crashes among professional drivers in East Africa
Researcher: Linda Masibo
Contact: linda.masibo@student.uhasselt.be

Purpose and Methodology of the Research
To gain knowledge about fatigued driving to develop a framework for developing interventions targeting fatigue driving with considerations for the local context. The survey seeks to identify mitigation strategies for fatigue driving proposed by respondents at a personal, organizational and government level in the East African context.

The survey will take about 10 minutes to complete.

Before starting the survey, please read the information below thoroughly:

- I have read the above information about this study (e.g. research objective)
- I understand the purpose of this research as well as what is expected of me during this research.
- I understand that my participation in this study is voluntary and that I have the right to discontinue my participation at any time during the intake (by closing the browser window).
- I do not have to give a reason for this, and I know that no disadvantage can arise for me. I understand that the results of this research may be used for scientific purposes and may be published.
- My name will not be published, and the confidentiality of my data is guaranteed at every stage of the research. I know that the results of this research will be kept for up to a 5-year period and will be deleted after this period.
- For any questions or comments I know I can contact after my participation Linda Masibo by email on linda.masibo@student.uhasselt.be.
- For any complaints or other concerns regarding the processing of personal data, I can contact the UHasselt data protection officer: dpo@uhasselt.be.
- For more information about exercising my rights or submitting a complaint, please see our.

I agree to take part in this study and agree that my answers will be registered.

○ Agree (1)

○ Disagree (4)

Section 1: Driver Information

Definition of terms Fatigue: a feeling of being drowsy, tired, bored, unable to concentrate, unable to sustain attention and mentally slow. It is a feeling of reduced alertness associated with drowsiness which impairs the capability and willingness to do a task.

Q 1 Gender

- ◯ Male (1)
- ◯ Female (2)
- ◯ Prefer not to say (3)

Q 2 What is your age group?

- ◯ 18 - 24 (1)
- ◯ 25- 34 (2)
- ◯ 35 - 44 (3)
- ◯ 45 - 54 (5)
- ◯ Over 55 (4)

Q 3 How many years have you been working as a driver?

- ◯ Less than 5 years (1)
- ◯ 5 to 10 years (2)
- ◯ More than 10 years (3)

Q 4 What describes you best?

- I own the vehicle I drive (5)
- I drive on behalf of a private individual (6)
- I drive for a company (7)
- I drive for a government institution or agency (8)
- Other, please indicate which (10)

____

Q 5 What is the nature of your work?

- Commuter public transport vehicle (1)
- Long-distance public transport vehicle (2)
- Long haul trucking (3)
- Private driver for a company or individual (4)
- Taxi or cab service (5)
- Ride hailing car or taxi service (Uber, taxify, bolt) (6)
- Tour company, tourist related activity (7)
- Other, please indicate which (8)

____

Q 6 In which country do you currently reside?

- Kenya
- Rwanda
- Tanzania
- Uganda
- South Sudan

Q 7 On average, how many days a week do you work?

- ◯ 1 to 2 days (1)
- ◯ 3 to 4 days (2)
- ◯ 5 to 6 days (3)
- ◯ 7 days (4)

Q 8 On average, how **many hours a day** do you work

- ◯ Less than 6 hours (1)
- ◯ 6 to 12 hours a day (2)
- ◯ 12 to 18 hours (3)
- ◯ More than 18 hours (4)

Q 9 How would you best describe your work schedule?

- ◯ Determined by you (1)
- ◯ Set by your employer and is predictable (2)
- ◯ Set by your employer, varies and is unpredictable (3)
- ◯ Other, please indicate which (4) ____________________

Q 10 Have you experienced problems related to fatigue such as difficulty concentrating, staying alert, sustaining attention, being mentally slower?

○ Yes (1)

○ Somewhat (2)

○ No (3)

Q 11 Section 2: Fatigue
Definition of terms Fatigue: a feeling of being drowsy, tired, bored, unable to concentrate, unable to sustain attention and mentally slow. It is a feeling of reduced alertness associated with drowsiness which impairs the capability and willingness to do a task.

Q 12 How much of a problem do you think fatigue is **in your industry**?

○ A major problem (1)

○ A substantial problem (2)

○ A moderate problem (3)

○ A minor problem (4)

○ Not a problem at all (5)

Q 13 How much of a problem is fatigue to **you personally** in your job?

○ A major problem (1)

○ A substantial problem (2)

○ A moderate problem (3)

○ A minor problem (4)

○ Not a problem at all (5)

Q 14 How often do you become fatigued while driving?

- ◯ On every trip (1)
- ◯ On most trips (2)
- ◯ On about half your trips (3)
- ◯ Occasionally (4)
- ◯ Very rarely (5)

Q 15 At what times during the day are you most likely to feel fatigued while working? Please select the hours you are likely to fatigue below.

- ◯ Midnight to 6am (1)
- ◯ 6am to 12 noon (midday) (2)
- ◯ 12 noon to 6pm (3)
- ◯ 6pm to midnight (4)

Q 16 Does being fatigued affect your driving?

- ◯ Yes (1)
- ◯ Somewhat (2)
- ◯ No (8)

Q 17 How often does fatigue affect your driving?

- ○ Always (1)
- ○ Most of the time (2)
- ○ About half the time (3)
- ○ Sometimes (4)
- ○ Never (5)

Q 18 How does fatigue worsen your driving? Please select all that apply

- ☐ Slower to react (1)
- ☐ Poorer steering (e.g. crossing lanes. under/over steering) (2)
- ☐ Poorer braking (3)
- ☐ Poorer gear changing (4)
- ☐ Poorer overtaking (5)
- ☐ Speeding (6)
- ☐ Driving too slowly (7)
- ☐ Poorer attention to traffic signs (8)
- ☐ Poorer awareness of other traffic/road users (9)
- ☐ Not applicable (11)

Q 19 Which of the following factors do you think contributes to **YOUR** fatigue while driving? Select all that apply. (Select all that apply)

- ☐ Long driving hours (1)
- ☐ Inadequate sleep (2)
- ☐ Use of alcohol (3)
- ☐ Poor vehicle condition (4)
- ☐ Poor road condition (5)
- ☐ Heavy traffic (6)
- ☐ Poor weather condition (7)
- ☐ Family problems (8)
- ☐ Poor diet/ irregular eating (9)
- ☐ After effects of stay awake drugs (10)
- ☐ None of the above (12)

Q 20 Part 1) Which of the following strategies do you use to manage feeling fatigued while driving for work? (Select all that apply)

- ☐ Stopping to eat (1)
- ☐ Stopping to rest (2)
- ☐ Stopping to sleep (3)
- ☐ Stopping for a meal (4)
- ☐ Eating while driving (5)
- ☐ Having a drink containing caffeine (e.g. coffee, tea, Coca-Cola) (6)
- ☐ Smoking (7)
- ☐ None of the above (16)

Q 21 Part 2) Which of the following strategies do you use to manage feeling fatigued while driving for work? (Select all that apply)

- ☐ Taking stay-awake drugs (8)
- ☐ Ignoring driving hours regulations to finish a trip when close to home (9)
- ☐ Taking a shower (10)
- ☐ Listening to music/radio (11)
- ☐ Singing (12)
- ☐ Adjusting ventilation (windows, air conditioning, heater) (13)
- ☐ None of the above (16)

Q 22 How well do you think fatigue is managed in your industry?

- ○ Extremely well (1)
- ○ Very well (2)
- ○ Moderately well (3)
- ○ Slightly well (4)
- ○ Not well at all (5)

Q 23 What do you think **your employer** should do to allow you to manage fatigue while driving? (Select all that apply)

- ☐ Provide more information and training on fatigue management (1)
- ☐ Efficient working conditions (e.g. quick loading in trucking, fixed departure times for transport operators) (2)
- ☐ Increased pay (3)
- ☐ Offer regular and reasonable working schedule (4)
- ☐ Organize driving schedules to avoid night driving (5)
- ☐ Allow more time off between trips (6)
- ☐ Use technology such as GPS to enforce working times (7)
- ☐ Not applicable, independent driver and/or not employed (10)

Q 24 What do you think the **government** should do to help you manage your fatigue? (Select all that apply)

- ☐ Provide more information and training on fatigue management (1)
- ☐ Put in place stricter policing to prevent the use of stimulant drugs to stay awake (2)
- ☐ Set up policies to manage driving hours (e.g. shorter trip hours) (3)
- ☐ Allow the use of stimulant drugs to stay awake (4)
- ☐ Enforce current driving hours more strictly (5)
- ☐ Offer better off road facilities (6)
- ☐ Provide greater flexibility to complete trips close to the end of working hours (7)
- ☐ Improve roads (8)
- ☐ Introduce dedicated lanes for different traffic (9)
- ☐ Create uniform driving and road rules at a national level (10)
- ☐ Allow for the industry to regulate itself (11)
- ☐ None of the above (13)

Q 25
Section 3: Driver Behaviour

How often do you go against driving/work-hour regulations? e.g. such as by either work more hours than permitted, take more rest brakes than required

- On every trip (1)
- On most trips (2)
- On about half your trips (3)
- Occasionally (4)
- Very rarely (5)

Q 26 If you do work contrary to driving/work hours regulations, why do you do so? You may select more than one option.

- Because of your tight schedule (1)
- Because of rewards or penalties associated with arriving early (2)
- To get in early to get the next load (3)
- In order to do enough trips to earn a living (4)
- In order to return home (5)
- In order to reach adequate rest facilities (6)
- In order to keep your job (7)
- Not applicable (9)

Q 27
Section 4: FATIGUE RELATED DANGERS All Drivers are likely to have encountered potentially dangerous things related to fatigue. This includes nodding

off, near miss, run-off-road, collision with something   Which of the following **have you experienced in the last 12 months?** Select all that apply

- ☐ Nodding off/ falling asleep (1)
- ☐ Having a near miss (2)
- ☐ Running off the road (3)
- ☐ Colliding with something (4)
- ☐ None of the above (8)

Q 28 Have you experienced a traffic crash in the last 12 months?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Have you experienced a traffic crash in the last 12 months? = Yes

Q 29 How **many** traffic crash were you involved with that resulted in the following?

- ☐ There **was property** damage or injury (1) ________________
- ☐ There **was no** property damage or injury (2) ________________

End of Block: Section 4

8.2. Interpretation of size of effect

TABLE 18 Interpretation of size of effect Cramer's V (*IBM Docs*, 2021)

Effect size (ES)	Interpretation
ES ≤ 0.2	The result is weak. Although the result is statistically significant, the fields are only weakly associated.
0.2 < ES ≤ 0.6	The result is moderate. The fields are moderately associated.
ES > 0.6	The result is strong. The fields are strongly associated.

8.3. Recruitment posters

The recruitment posters were designed for the specific target audiences and based on mode of distribution.


MASTERS THESIS RESEARCH: EAST AFRICA
FATIGUE RESEARCH
Research Subject: Fatigue
Target population: Professional drivers
Goal of the Research
The study seeks to understand fatigue as a cause of traffic crashes among professional drivers
Disclaimer: Data collected is pseudonymised and collected in accordance with GDRP.
FILL OUT THE MASTERS THESIS SURVEY*|
LINK: SHORTURL.AT/SBMU1
Image: Unsplash
Professional drivers: Bus, truck, private car, taxi etc