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MAUHAZARD: AN INTERACTIVE TOOL TO ASSESS HAZARD PERCEPTION SKILLS OF DRIVERS IN MAURITIUS

Final Report

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MauHazard: An Interactive Tool to Assess Hazard Perception Skills of Drivers in Mauritius

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Executive Summary

The number of road accidents has been continuously increasing over the past few years in Mauritius although drivers have to go through training and strict testing phases before earning a competent driving license. To address this growing concern several measures such as speed cameras, roadblock checks, awareness campaigns and Alco-test have been put in place by concern authorities in an aim of reducing road accidents. However, limited work has been done in the area of road hazards and assessment of hazard perception level of Mauritanian drivers. Taking cognizance of this limitation, this research study aims to develop an interactive web based multimedia tool named "MauHazard" to assess the hazard perception skills of drivers specific to the Mauritius context. To being with, a literature review was conducted to investigate the key parameters involved for the development of the hazard perception tool. In this phase, there has been the identification of key road traffic hazards specific to the Mauritian context and a hazard taxonomy was proposed. In addition, there has been also the recording of real road traffic footage based on the identified hazards. After the compilation of traffic hazards was completed, the interactive web-based hazard perception tool was developed and tested against its pre-defined list of functional requirements. Following the development phase, 273 participants were recruited to take part in the hazard perception test and after which the data collated was entered in SPSS for statistical analysis.

Results showed that the overall average score of the participants who took the hazard perception test was 28.1 points. This score indicates a poor performance and is related to various factors. The research participants who were aged between 60 to 70 years old had a poorer hazard perception level with an average overall score of 16.0 points as compared to participants who were less than 40 years old with an average overall score of 28.1 points. As such, it could be concluded that the hazard perception ability declines with increasing age after 40 years mainly due to poor cognitive ability like useful driving field of view and other vision related factors. Furthermore, it could also be observed that the participants who had a driving experience of 6 months equally had a lower hazard perception level with an overall average score of 26.0 points as opposed to participants with a driving experience above 5 years old. The novice drivers had a very poor hazard perception level and can be attributed to inexperience, impoverished mental models and low number of past exposures as compared to experienced drivers who were better able to perceive and identify road hazards with the proper risk interval. Since the research study revealed a poor hazard perception level among Mauritian drivers, therefore it is vital to provide appropriate training that will not only improve the hazard perception skills of drivers in Mauritius but will also contribute in significantly reducing accident liabilities.

Acknowledgements

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Table of Contents

List of Figures

List of Tables

List of Acronyms

CGI - Computer Generated Images

DfT - Department for Transport

DVSA - Driver and Vehicle Standards Agency

HPS - Hazard Perception Skill

HP - Hazard Perception

HPT - Hazard Perception Test

LGV - Large Goods Vehicle

NSW- New South Wales

TRL - Traffic Research Laboratory

PCV - Passenger Carrying Vehicle

Chapter 1 – Introduction

1.1 Background of Study

Despite the fact drivers have to go through training and testing phases before earning their driving license in Mauritius, the number of road accidents has been continuously increasing over the past few years within the island. According to Central Statistics Office of Mauritius (2018), the number of road traffic accidents registered during the year 2018 was 29,075. Among these accidents, the majority, 26,389 (90.8%) were non-injury, 132 were fatal, 487 caused serious injuries and 2,067 were slight injuries. The report also reveals that among the casualties during the year 2018, some 39.3% were riders of auto/motor cycles, 25.9% passengers, 15.5% drivers, 15.3% pedestrians and 4% pedal cyclists.

To address this growing concern of road accidents in Mauritius, various measures have been implemented by different stakeholders. For instance, in order to control speeding on the road, various speed cameras have been fixed at different locations around the island (Rajaysur, 2015). Moreover, different mobile speed traps are also being randomly deployed everyday around Mauritius so as to further detect drivers exceeding the speed limit in regions not having fixed speed cameras. For controlling drunken drivers, several patrolling teams are regularly deployed to various regions within the island to perform Alco-test exercises in suspected cases (Mauritius Police Force, 2005). Sensitization campaigns have also been implemented on road safety. Although various measures have been taken to address issues like drink driving, speeding and low road safety awareness, among others, limited work has done in the area of road hazard and hazard perception of drivers in Mauritius.

1.2 Problem Statement

In the current driving license test in Mauritius, candidates have to firstly go through a computerized Audio Visual Test on traffic signs. The test will assess their ability to read and understand traffic signs, their knowledge of the rules on the road, and their understanding of traffic signals by drivers and police (Mauritius Police Force, 2014). When the Audio Test has been successfully completed, candidates then have to go through a practical driving test to assess their driving competency on the road. As such, Mauritius is yet to include the Hazard Perception Test (HPT) in the existing process to obtain the driving license even though many countries (e.g. US, Dubai, New Zealand, among others) have already mandated such test as part of licensing for novice drivers (Smith, et al., 2009). However, limited tools are available in the Mauritian context and thus owing to this lack, it is of utmost importance to develop an interactive tool so as to assess the hazard perception level of drivers. Besides, with the growing number of road accidents in the island, inclusion of such a test in Mauritius is becoming necessary as hazard perception training was found to significantly decrease the reaction time of drivers and a reduced reaction time also means quicker response to hazardous situations which could potentially avoid accidents (Crick & McKenna, 1992; Deery, 1999).

1.3 Aim and Objectives

The aim of this research project is to investigate and develop an interactive hazard perception tool to assess the hazard perception skills of drivers in Mauritius.

The set of objectives of the project are:

1. Identification and definition of key road traffic hazards within the context of Mauritius,
2. Recording videos of simulated hazardous situations identified in Objective 1,
3. Design and implementation of a multimedia tool for training and assessing hazard perception using the videos recorded in Objective 2,
4. Assessment of hazard perception levels of different categories of drivers using the tool developed in Objective 3,
5. Gather information on the perspectives of drivers and trainers with regards to the potential of inclusion of the implemented tool in Objective 3 in the driving test in Mauritius,
6. Assess the implementation of the proposed solution as part of the driving license test in Mauritius,
7. Raise awareness on the importance of Hazard Perception training and assessment among key stakeholders in Mauritius through knowledge dissemination.

1.4 Summary of Key Phases of Project

Figure 1.1 displays the proposed roadmap for assessing the hazard perception skill of drivers along with the various phases. To begin with, there has been a compilation of traffic hazards within the context of Mauritius to form a hazard taxonomy. In the second phase, there has been the recording of traffic footage based on the identified hazards from the first phase. Essentially, in the third phase, there has been the development of an interactive web-based application to measure the hazard perception level of drivers. Eventually, after the development of the tool in phase four, it involved the assessment of the hazard perception skill of Mauritian drivers that was conducted with three categories of road users. Ultimately, in the last phase there has been the analysis of results regarding the hazard perception level of Mauritian drivers as well as the awareness on the importance of Hazard Perception testing and training.

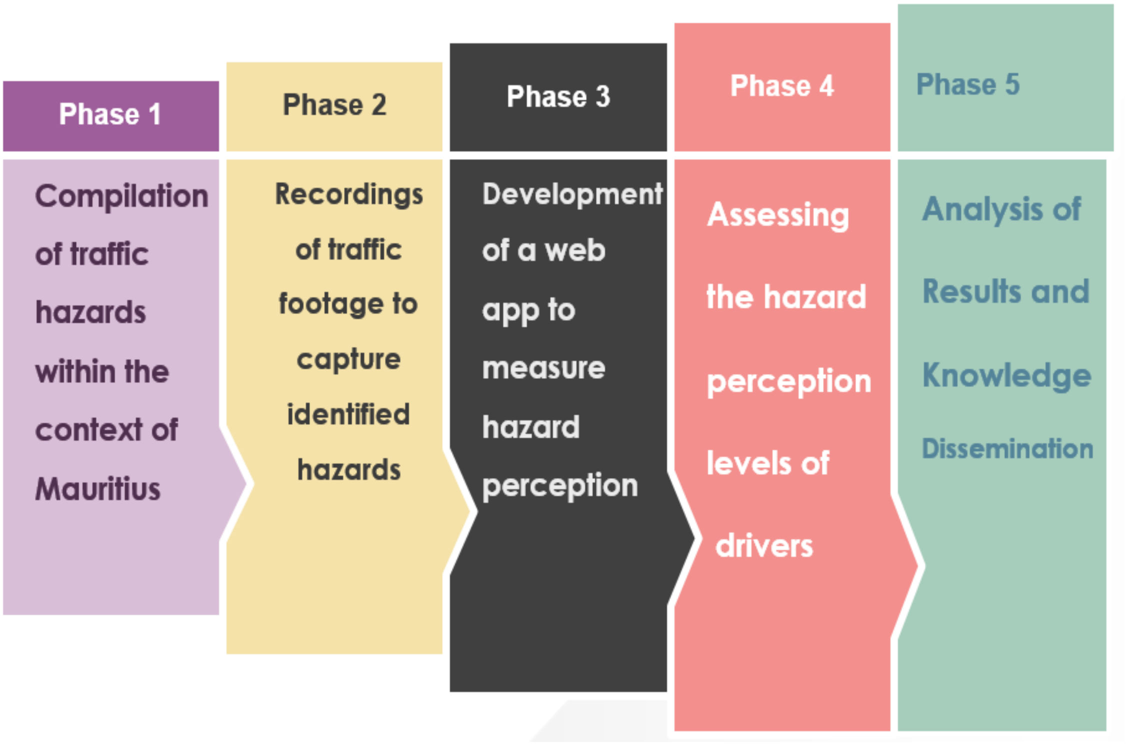

Figure 1.1: Summary of key Phases of the project

1.5 Chapter Summary

The report begins with an insight on the research project to be developed, the problem statement, aim and objectives in conjunction with the various research questions to be answered. The following provides a summary of the different chapters present within the research report:

Chapter 2 - Road Accidents and Causes

Following the Introduction, chapter two focuses on the growing amounts of road accidents in Mauritius. In addition, the importance of road transport, the main causes of road accidents and various road hazards are reviewed and classified.

Chapter 3 - A Classification of Road Hazards

This chapter highlights on the classification of road hazards which are applied to the Mauritian context. As such, the main hazard categories include road hazards, animal related hazards, weather conditions and ultimately human related hazards. A taxonomy for road hazards has also been presented.

Chapter 4 - Reducing Road Accident Risk through Improved Hazard Perception Skills

This chapter principally focuses on the mechanisms so as to improve the Hazard Perception Skill amongst drivers as well as on the concept of reducing road accidents. Moreover, a comparative analysis of existing tools with regards to Hazard Perception Skill is also given.

Chapter 5 – Analysis and Design

Chapter five describes the functional and non-functional requirements of the web-application. In-particular, the design phase mostly encompass the different types of Unified Modeling Language (UML) diagrams such as use case diagram, class diagram, collaboration and sequence diagrams which are essentially associated with the system design. After the UML schematics were made, the user interface screen layouts were designed via balsamic based on the pre-defined list of functional requirements.

Chapter 6 – Implementation and Testing

This chapter mainly focuses on the development approach with regards to the proposed web-based application 'Mau Hazard' was implemented along with the different component that are involved within the project structure. Following the implementation, the testing section presents the testing methodology which was used to assess the functional requirements of the web application together with the results that were obtained.

Chapter 7– Hazard Perception Test

Following the development of the web-based application for assessing the hazard perception skills of Mauritian drivers, this particular chapter provides information about how the hazard perception test was designed and the method and procedure used for evaluating the hazard perception level of Mauritian drivers.

Chapter 8– Results and Discussions

This chapter consists of the descriptions and results which were obtained from the Hazard Perception Test conducted. The data collected from tests were entered and analyzed using SPSS software. The results were essentially represented through graphs, pie charts, box-plots and tables. Moreover, a proposed roadmap was also included for assessing the implementation of the proposed Hazard perception Test as part of the current licensing process in Mauritius.

Chapter 2 – Road Accidents and Causes

2.1 Essence of Road Transport in the Contemporary Society

Transportation is the actual physical movement of people and goods from one place to another and it plays an important role in the economic development of any region. (Ahukannah et al., 2003; Deepa & Vemballue, 2014). Economic growth that result in higher incomes and a rising living standards are expected to create greater demands for travel for both work and non-work/leisure purposes (Deepa & Vemballue, 2014). Efficient infrastructure warranting accessibility attracts centres of production and consumption and thus impacts the regional economy positively (Marolda, 2008). It is the density and the quality of the road infrastructure which primarily determine the competitiveness of a country (Ivanova & Masarova, 2013). Also, poor road infrastructure poses hindrance to foreign investments in countries depending on them in terms of their economic performance and competitiveness enhancement (Ivanova & Masarova, 2013). The Road infrastructure in Mauritius has enabled all economic activities to take place and have been determinant in attracting investment in the country and in 2011, there was approximately 2066 kilometers of main roads in Mauritius (Gungea, 2011).

According to Statistics Mauritius (2018), at the end of June 2018, there were 543,623 vehicles registered at the National Transport Authority and this represents an increase of 11,826 vehicles (2.2%) vehicles as compared to the end of year 2017 where the number of registered vehicles was 531,797. From the same source and using the figures, a representation is shown in Figure 2.1 below for the number of vehicles constantly integrating Mauritian roads from the year 2010 to the end of June 2017.

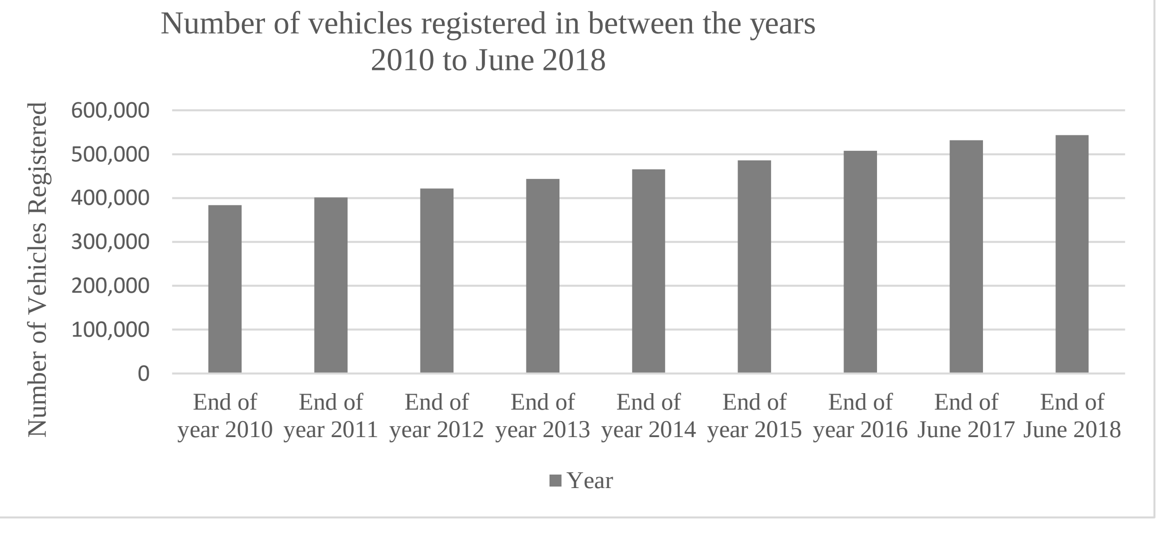

Figure 2.1: Representation vehicles fleet officially registered in Mauritius from year 2010 to the end of June 2018.

Additionally, Hilbert (2017) has showed how the number of cars, motorcycles, vans, bus and lorry has gradually increased as showed in Table 2.1. Moreover, the vehicles that are more numerous in Mauritius are Cars and Motorcycles.

	2007	**2010**	**2013**	**2016**	**2017**	**2018 (Jan - Jun)**
Total	334,145	384,115	443,495	507,676	531,797	543,623
Cars	99,770	127,363	160,701	202,696	218,976	226,645
Motorcycles	142,606	159,329	180,611	199,399	88,360	91,378
Vans	24,934	25,914	26,624	27,656	28,121	28,323
Bus	2,753	2,845	2,963	2,980	3,101	3,097
Lorry	12,536	13,186	14,061	14,645	15,024	15,234

Table 2.1: List of registered vehicles in Mauritius

It is therefore legitimate and indispensable to safeguard the road transport industry that is vital to economic growth, social development, prosperity, ultimately and peace which plays a crucial role in everyone's life in industrialized and developing countries alike by meeting the demand for the sustainable mobility of both people and goods (Datta, 2011). However, during recent years, concerns have been raised over the growing number of road accidents.

2.2 The Growing Concerns over Road Accidents

Annually, nearly 1.2 million people die and millions more are injured or disabled as a result of road crashes, mostly in low-income and middle-income countries (World Health Organization, 2007). According to the same source, road traffic injuries are a one of the main leading cause of death and injury around the world. In Great Britain, there were 1,792 reported road death in the year 2016, an increase of 4% compared to the previous year (Statistics National, 2017). Also, the International Road Transport Union (2007) accident expert teams have investigated 624 accidents and the main cause of the accidents was linked to human error in 85.2% of one of the road participants (truck driver, car driver, pedestrians and among others). However, out of the accidents linked to human error, only 25% were caused by the driver and other factors such as weather conditions 4.4%, infrastructure conditions 5.1% or technical failures of the vehicle 5.3% played only a minor role (International Road Transport Union, 2007). In 2016, the Europe roads had on average only about 8 % of road fatalities occurred on motorways; 37% happened in urban areas; most (55%) occurred on rural roads (European Commission, 2017). Globally, road traffic crashes are a leading cause of death among young people, and the main cause of death among those aged 15–29 years (World Health Organization, 2015) and have impacted negatively to the society and its economy (Osoro, et al., 2015). Similarly, the number of road accidents have also been increasing in Mauritius.

Road traffic accidents are becoming alarming in Mauritius and since the number of vehicles and drivers are increasing, accidents are becoming more frequent. The average number of person killed over the past 10 years is 149 and number of seriously injured is 268 annually (Statistics Mauritius, 2017). With a number of speed cameras installed and millions collected in terms of fines, the year 2014 has been lethal concerning road accidents than the year 2013 which had fewer cameras. According to the Statistics Mauritius (2017), the number of motor vehicles involved in accidents resulting in casualties was 2,291 during the first semester of 2017 against 2,074 for the same period of 2016. Moreover, during the past 10 years in Mauritius between the year 2007 to June 2017, the number of accidents, death, serious and light injuries have constantly been increasing at an alarming rate as shown in Table 2.2 below (Hilbert, 2017).

	2007	**2010**	**2013**	**2016**	**2017 (Jan-June)**
Number of accidents	20,519	21,243	23,563	29,277	15,037
Per 100,000 persons	1,709	1,755	1,936	2,397	N.A
Death	140	158	136	144	73
Serious Injuries	500	569	465	512	307
Light Injuries	2,415	2,913	3,009	3,206	1,624

Table 2.2: Number of Death, Serious and Light injuries owing toRoad Accidents between the year 2007 to Mid-2017. (Statistics Mauritius, 2017)

From the Police Statistics (2017), the Minister of Public Infrastructure and Land Transport of Mauritius has stated in a reply in the National Assembly on 31st October 2017 that 44 % of the fatal accidents occurred at night and 50% during midday. He also added that the people that is more vulnerable are aged between 25 and 50 years.

Furthermore, as presented in Figure 2.2, in the first semester of 2017, the number of road accidents went up by 4.0% to reach 15,037 as compared to 14,452 recorded during the corresponding period of 2016.

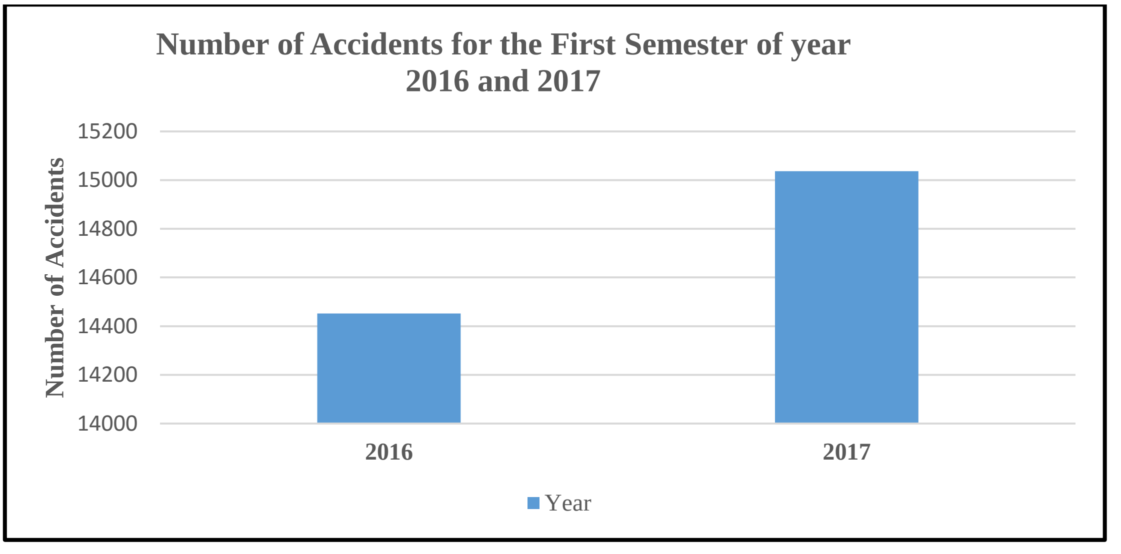

Figure 2.2: Comparing the number of accidents for the first semester of 2016 and 2017 in Mauritius

In addition, compared to the same period (January to June) in 2016, casualty accidents went up by 7.4% and non-injury accidents rose by 3.7%. During the first semester of 2017 as shown in Figure 2.3, 73 persons died as a result of road accidents against 72 during the corresponding period of 2016, showing an increase of 1.4% (Statistics Mauritius, 2018).

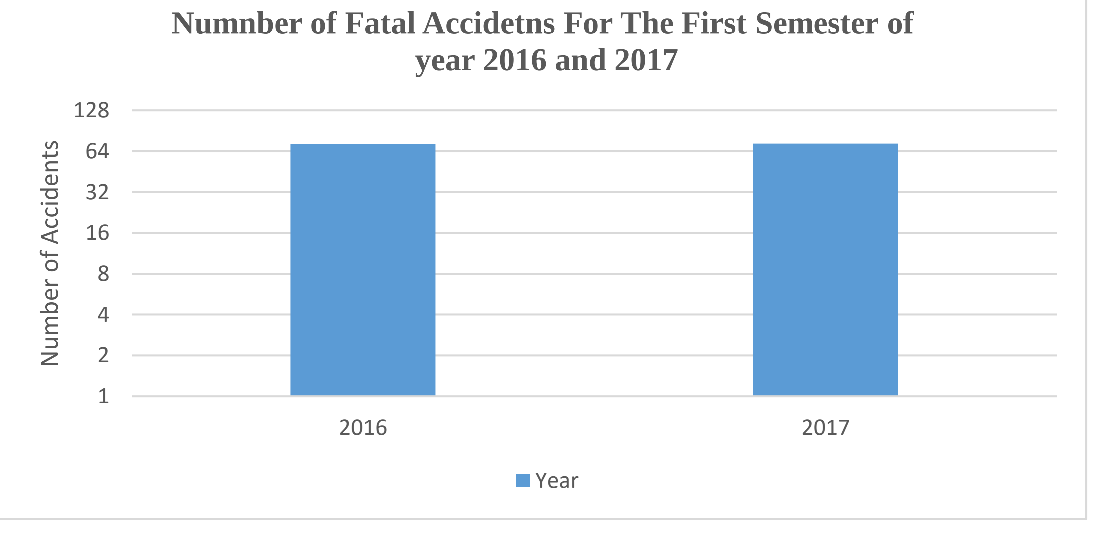

Figure 2.3: Fatal accidents during the first semesters of the year 2016 and 2017.

Besides, the total number of vehicles (both motor and non-motor) involved in road accidents was 28,973 (+2.4%) in the first semester of 2017 against 28,306 in the corresponding period of the preceding year as shown below in Figure 2.4 (Statistics Mauritius, 2018).

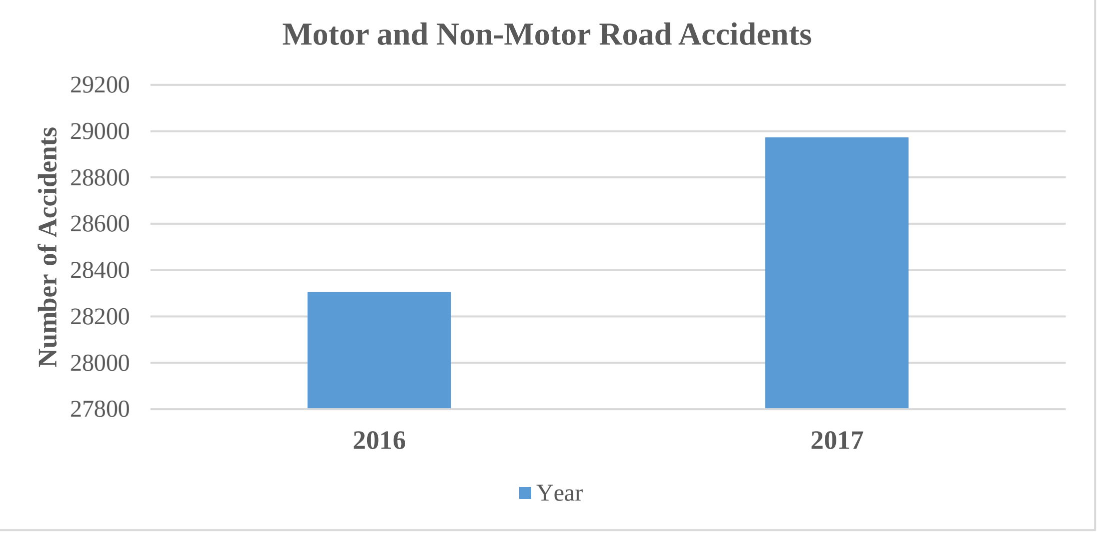

Figure 2.4: Total number of vehicles involved in road accidents in first semester of 2016 and 2017

However, among the vehicles involved in accident casualties for the first semester of 2017, 36.6% were private cars, another 36.4% were motor/auto cycles, 6.5% were buses and 5.9 % were vans as shown in Figure 2.5 below.

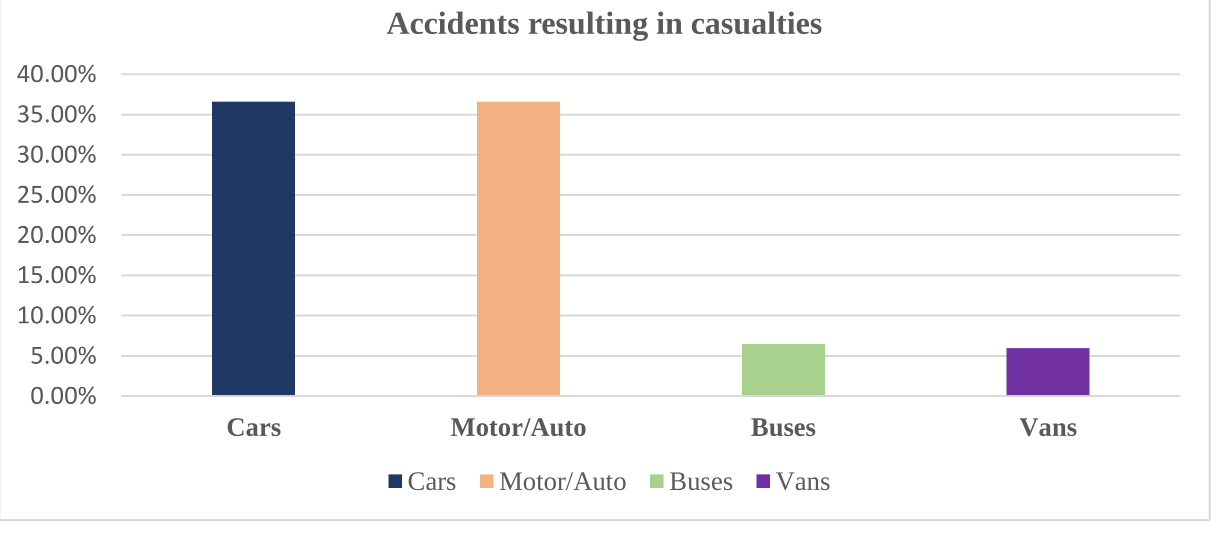

Figure 2.5: Accidents Statistics of vehicles for the first semester of 2017 (Statistics Mauritius, 2017)

Among these accidents, the majority, 13,557 (90.2%) were non-injury, 69 fatal, 257 caused serious injuries and 1,154 slight injuries. Despite the sensitization campaigns and measures to reduce the number of accidents and deaths, the death toll has never been this high. Moreover, according to Statistics Mauritius (2018), during the year 2017, some 88 persons died as a result of road accidents. Therefore, in order to address the growing concern related to the rise in the number of road traffic accidents, it is of utmost importance to investigate on the causes of accidents in Mauritius.

2.3 Causes of Road Accidents

According to the Government Information Service Mauritius (2015), 75% of the road fatalities that have occurred since the beginning of the year 2015 are the result of speeding and drink driving in Mauritius (Government Information Service, 2015). Also, the main factors causing a road accident in Mauritius are the infrastructure, condition of the vehicle and the behavior of the driver (Kanhye, 2017). In December 2002, a report titled 'Road Accidents Mauritius' by the authors Jewon & Nathoo (2002) was published by the Ministry of Public Infrastructure, Land Transport and Shipping where many aspects of road accidents where and road safety issues for the years 1996 to 2002 were reported.

Nonetheless, we did not come across any recent official publication about the statistics and exact causes of accidents in Mauritius. Besides, there were some sources found on some online newspapers and articles about the causes of accidents in Mauritius. In Table 2.3 below provides a list of the causes of accidents from different sources.

Causes of Road Accidents	
1. According to the Road Safety Unit, below is a list of the causes of road accidents in Mauritius.	
i. Alcohol Consumption	Drinking and driving will not keep the driver focused on the road.
ii. Use of Mobile Phone	Using mobile phone is a sort of distraction which can lead to an accident.
iii. Speeding	Speeding will cause the car to be less stable and difficult to handle.
2. Jewon & Nathoo (2002) discussed a main cause of road accidents in Mauritius.	

i. Poor Hazard Perception	Not being able to detect a hazard which could head to a road accident.
3. From a Mauritian Newspaper, the following causes of road accidents were gathered (Gungea, 2015).	
i. Indiscipline	Many drivers fail miserably to abide by traffic regulations and hence, they either provoke accidents or are victims of accidents.
ii. Drowsy Driving	Being tired often diminishes a person's reaction time and this will cause driving to be hard.
iii. Climatic Conditions	Many drivers may not adapt their driving to prevailing climatic conditions.

Table 2.3: Causes of road accidents from different sources.

The identified key causes of road accidents from different sources are further described as follows:

2.3.1 Drink Driving

Each year, thousands of car accidents with drunk drivers cause tragedy and grief, making it one of the top causes of automobile accidents (Micheal, 2017). An estimated 5,620 drink-drive accidents took place in Great Britain in 2014, according to data published by the Department for Transport (DfT); an equivalent of 15 accidents a day and the accidents resulted in 240 deaths, representing 14% of all deaths on the roads, with 8,220 casualties in total (Robineau, 2016). Every day, about 28 people in the United States die in motor vehicle crashes that involve an alcohol-impaired driver which makes one death every 51 minutes and the annual cost of alcohol-related crashes totals more than $44 billion (Department of Transportation (US), National Highway Traffic Safety Administration, 2015).

Consuming alcohol causes drowsiness, blurred vision, slowed reflexes, affects judgement, coordination and promotes over-confidence (Ivey, et al., 2016). Moreover, during the festive period from 31st December 2016 to 9th January 2017, 51 drivers in Mauritius have been tested positive and were placed in drunk tank owing to driving under alcohol influence (Duval, 2017). Also, the Mauritius Police Force has been putting a lot of emphasis on drunken driving and speeding. The consumption of alcohol, even in relatively small amounts, increases the risk of being involved in a crash for motorists and pedestrians (World Health Organization, 2007). Below is a description of permissible alcohol limits in Mauritius along with possible penalties (Ministry of Public Infrastructure and Transport, 2018):

The legally allowed permissible limits of alcohol for Mauritius are:

- 20 milligrams of alcohol in 100ml of blood.
- 27 milligrams of alcohol in 100ml of urine.
- 09 micrograms of alcohol in 100ml of breath.

In case a driver has been caught drinking and driving, the penalties are:

- First conviction – Fine not less than Rs 20,000 and not more than Rs 50,000
- Imprisonment is permissible and it is not more than 5 years.
- Second conviction - Fine not less than Rs 50,000 and not more than Rs 75,000.
- Imprisonment is obligatory and between 1 year to 8 years.
- Disqualification of driving license

2.3.2 Speeding

Speeding has been identified as a key risk factor in road traffic injuries, influencing both the risk of a road crash as well as the severity of the injuries that result from crashes (World Health Organization, 2004). Excessive speed makes it much more difficult for drivers to control their vehicles. As such, less time is taken to correctly identify, evaluate and react to the situation on the road, the vehicle's braking distance is increased, it becomes more likely that the driver will lose control over the vehicle, and other road users have less time to avoid an accident (Polish Road Safety Observatory, 2014). Speed also reduces the time drivers have to identify and react to a problem which could cause a driver to have less time to identify a risk and react to what is happening (Galbraith & Townsend, 2011). In Mauritius, speeding is one of the main causes of accidents and the number of tickets handed out for speeding increased by 18% to reach 66,461 in the year 2013 (Gungea, 2015). According to the same source, from May to December 2013, around 27,457 tickets were issued under the Penalty Points Management System.

Additionally, speed choice is related to the drivers' motives, attitudes, risk perception and characteristics of the road environment (SafetyNet, 2009). A report in 2002 from the TMRSU (Traffic Management & Road Safety Unit) stated that, speed driving is a major cause of road accidents, accounting for one-third of all fatal accidents (Nunkoo, 2015). Up to end December 2014, 80,000 drivers in Mauritius had been flashed by speed cameras and among these 70,000 were not at their first offence (Government Information Service, 2015). Additionally, the same source stated during the same period, 21 driving licenses were suspended and 13 cases were being contested in court. In Mauritius, 38,476 motorists had been caught speeding in 2014 and this has brought up to

76,952,000 rupees as fine to the State of Mauritius (Indian Ocean Times, 2016). Typically, 40 to 50% of the drivers travel faster than the speed limit and 10 to 20% of them exceed the speed limit by more than 10 km/h (SafetyNet, 2009). Speed limit offences processed by police continue to rise which could be a result of a drastic increase in the level of enforcement using speed radars (Jewon & Nathoo, 2002). Drivers need time to process information: first, they need to identify a problem; after, they need time to decide whether or not to react to the problem and what reaction is appropriate; and, finally, they need time to take the appropriate action (Galbraith & Townsend, 2011). Excess and inappropriate speed are responsible for a high proportion of the mortality and morbidity that result from road crashes (World Health Organization, 2007). The speed limits in force in Mauritius are described in Table 2.4 below.

The speed limit regulations in Km/hr				
	Motorway	**A road**	**B road**	**Other road**
Motor car	90	80	60	40
Bus with Maximum Gross Weight less than 3.5 tons	80	80	60	40
Bus with Maximum Gross Weight more than 3.5 tons	70	60	50	40
Goods vehicles or Articulated vehicles with Maximum Gross Weight less than 3.5 tons	80	80	60	40
Goods vehicles or Articulated vehicles with Maximum Gross Weight more than 3.5 tons	70	60	50	40
Motor vehicles drawing one trailer with Maximum Gross Weight less than 3.5 tons	55	60	50	40
Motor vehicles drawing one trailer with Maximum Gross Weight more than 3.5 tons	55	40	40	40

Motor vehicles drawing more than one trailer	40	40	40	40

Table 2.4: Driving Speed Limits of Vehicles in Mauritius

(The Mauritius Police Force, 2018)

In high-income countries, speed contributes to about 30% of deaths on the road, while in some low-income and middle-income countries, speed is estimated to be the main contributory factor in about half of all road crashes (World Health Organization, 2004). With regards to speeding, the Ministry of Public Infrastructure and Transport, (2018) has introduced a graduated scale of fines for persons convicted of exceeding speed limits which is, the level of sanction escalates as the level of the speeding above the authorized speed limit increases. As such, a minimum fine of Rs 2,500 will be effected for exceeding the speed limit by not more than 15 kilometers per hour. Moreover, a fine of Rs 5,000 for exceeding the speed limit by more than 15 kilometers but not exceeding above 25 kilometers per hour; and lastly a fine of Rs 10,000 for driving at a speed of more than 25 kilometers per hour above the authorized speed limit.

2.3.3 Poor Hazard Perception

Poor hazard perception is the inability of drivers, in particular, to identify possible risks or dangers on or near the road, where drivers think that they have above average driving skills and thus road accidents can be avoided (Jewon & Nathoo, 2002). Driver hazard perception is a vital driving ability that allows drivers to detect impending collision risks in a complicated traffic environment (Borowsky, et al., 2012). Therefore, from this perspective, it is very important for road users to identify hazard appropriately within the required time so as to avoid accidents.

2.3.4 Distracted Driving

Vision has been considered as the most important sense for safe driving (National Safety Council, 2012). Distracted driving is quickly becoming the number one reason for car accidents (Heiting & Irwin, 2016). There are different types of driver distraction that can lead to impaired driving, usually divided into those where the source of distraction is internal to the vehicle – such as tuning a radio, or using a mobile phone, and those external to the vehicle – such as looking at billboards or watching people on the side of the road (World Health Organization, 2011). The United States (U.S.) Department of Transportation (DOT), defined distracted driving as “any activity that could divert a person’s attention away from the primary task of driving’’ (Edward, 2012).According to Edward (2012), there are four types of distractions:

1. Visual – taking eyes off the road;
2. Manual – taking hands off the steering wheel;
3. Cognitive – taking the mind off what the driver is doing; and
4. Auditory – hearing something not related to the road.

Recently, a study showed that using a hand-held or hands-free mobile phone while driving is a significant distraction, and this can increase the risk of the driver crashing (Bakarkhan, 2012). Also, it has been previously estimated indicate that drivers using cell phones look but fail to see up to 50 percent of the information in their driving environment (Strayer, 2007). The vast majority of drivers (39 % to 45%) reported using their mobile phone at least sometimes while driving, and it is estimated that at any given moment during the day, 2 to 6% of the drivers is using a mobile phone in Mauritius (Road Safety Authority, 2010).

2.3.5 Indiscipline / Reckless Driving

Reckless driving includes either accidental or intentional speeding, tailgating, cutting off other drivers, running red-lights, frequent lane changing and obstruction of other cars. (Han & Yang, 2009). Traffic accidents or regulation violations may occur by drivers with occasional reckless driving behavior by chance or with the habitual reckless driving behavior (Jang, 2006). These reckless practices are also in violation of traffic regulations and may lead to accidents and as a result, the lives of nearby drivers, passengers and pedestrians are threatened. Additionally, substantial social and economic losses may be incurred (Han & Yang, 2009). The number of offences for driving without due care in Mauritius has increased by 14% to reach 1,630 in 2013 (Gungea, 2015). Similarly, the same source stated that fines in Mauritius for failing to wear seat belts stood at 9,201 and around 7,302 drivers have been caught using mobile phones while driving in 2013. Among youth, the high rate of traffic accidents result from inexperience (Mayhew, et al., 2003), and a higher tendency to drive recklessly (Smart & Vassallo, 2012).

In fact, reckless driving accounted for approximately 51% of the total economic crash costs ($230.6 billion) of all 16.4 million U.S. motor vehicle collisions in 2000 (Blincoe, et al., 2002). To reduce the number of (fatal) traffic accidents among adolescents, expansion of the current knowledge of risk factors is crucial. Risk factors for reckless driving known so far include male gender, younger age, and higher sensation seeking tendencies (Dahlen, et al., 2005). In addition, these actions correspond to non-economic driving, causing an inevitable and unnecessary waste of fuel (Han & Yang, 2009).

Below is a list of unsafe acts of drivers as an apparent cause of road accidents (Singh et al., 2015):

1. Failure to observe clearance
2. Failure to signal intentions
3. Improper turning
4. Following too close a vehicle
5. Improper overtaking
6. Wrong side driving
7. Improper backing
8. Personal impairment

The Road Traffic Act published by the Director of Public Prosecutions of Mauritius states that any person who causes the death of another person by driving a motor vehicle dangerously on a road or other public place, shall commit an offence and shall, on conviction, be liable to a fine of not less than 25,000 rupees nor more than 75,000 rupees and to imprisonment for a term not exceeding 8 years. Moreover, the same penalty applies if the driver is driving at a dangerous speed or manner having regard to all the circumstances of the case, including the nature, condition and use of the road or other public place, and the amount of traffic which is actually, or which might reasonably be expected to be, on the road or public place. Therefore, it is the driver's responsibility to drive safely.

2.3.6 Drowsy Driving

Drowsiness is second only to alcohol as the leading cause of motor vehicle accidents and some research has estimated that sleepiness plays a major role in as many as 25% of accidents on the highway each year (Arnedt, 2001). Sleep-deprived driving is one of the main causes of motor vehicle accidents, and it can impair the human brain as much as alcohol can (Chintaram, 2015). A survey conducted in Mauritius by the same author interviewed taxi drivers and employees working late night or on a shift system if they drive in a state of drowsiness. The survey showed that 62% of the taxi drivers admit they had to pull over to make a small nap or sprinkle water on face due to drowsiness and 47% of employees acknowledge to have started to doze off on the wheel. Therefore, it became more than obvious now to quickly find a solution to this alarming issue. Thus, several campaigns for example "Don't Fight Sleep" in Mauritius were raised to bring consciousness among drivers about the impact of drowsiness while driving. It is technically distinct from fatigue, which has been defined as a "disinclination to continue performing the task at hand" (Brown, 1994). Fatigue can result from physical labor as well as repetitive activities such as monitoring a display screen or driving a truck long distances. An individual can be fatigued without being sleepy, but conditions that produce fatigue also expose underlying sleepiness (Stutts, et al., 1999). The

American Academy of sleep Medicine (AASM) estimates 80,000 drivers fall asleep behind the wheel every day and 250,000 accidents occur every year related to sleep (Chintaram, 2015).

Most people are aware of the dangers of driving while intoxicated, but many do not know that drowsiness also impairs judgment, performance and reaction times just like alcohol and drugs (National Sleep Foundation, 2007). From the same source, the National Highway Traffic Safety Administration conservatively estimated that 100,000 police-reported crashes each year are caused primarily by drowsy driving and that such crashes result in more than 1,550 deaths, 71,000 injuries and $12.5 billion in monetary losses. Drowsy driving crashes are more likely to occur at night or in the mid-afternoon (times of greater sleepiness), to occur on roads with higher speeds, to involve a single vehicle running off the road, and to result in serious injuries (Arnedt, 2001). According to the Traffic Branch of Mauritius, many drivers who work at night lack concentration while driving which often diminishes a person's reaction time and easily lose control of their vehicle (Gungea, 2015).

2.3.7 Weather Conditions

Weather-related crashes are defined as those crashes that occur in adverse weather (i.e., rain, fog, snow, sleet) or on slick pavement (i.e., wet pavement, snowy/slushy pavement, or icy pavement) (Liu, 2013). The onset of adverse weather can cause severe disruption of road traffic, causing not only inconvenience, but often the postponement or cancellation of journeys altogether (Edwards, 1999). At dusk and at night, a driver loses the ability to see any detail and dark objects easily merge into the background (Theory Test Advice, 2017). The driving task becomes more complex when weather-related conditions of reduced visibility are accompanied by wet surfaces (Chakrabartya & Guptab, 2013). According to Liu (2013), in terms of accident severity, among all weather-related accidents, 41.6% involve personal injury and 0.47% cause fatalities. In some areas in Mauritius, visibility low due to fog and many drivers still do not adapt their driving to prevailing climatic conditions and thus leads to unfortunate road events (Gungea, 2015).

2.3.8 Negligence

Negligence generally means careless or inadvertent conduct that results in harm or damage, which is quite common in automobile accidents (Reuters, 2017). A driver must be attentive in order to avoid injuring other motorists, passengers, pedestrians or anyone that on the road (Goguen, 2017). Therefore, if a driver is not reasonably careful and injures someone as a result, the driver is liable for injuring the accident victim. Distracted driving is a suitable example of negligence because it illustrates a wide range of careless conduct that endangers the safety of others.

2.3.9 Pedestrians

Even though walking is a mode of transportation, one is forced to agree in the light of the number and severity of accidents involving pedestrians, the people using this means of locomotion are still at considerable risk (Kouabenan & Guyot, 2004). In New Zealand roads, 30 pedestrians died, 221 pedestrians were seriously injured, and 618 pedestrians suffered minor injuries in police-reported crashes in the year 2013 (Ministry of Transport, 2014). The same source stated that the total social cost of police reported crashes involving pedestrians was approximately $353 million which was about 12 percent of the social cost associated with all fatal or injury crashes in 2013. Provision for pedestrians and cyclists in low-income countries is rudimentary or even non-existent.

2.3.10 Vehicle Problem

While human error is found to be the most frequent contributing factor to road accidents, vehicle defects are reported as playing a role much less frequently (Moodley & Allopi, 2008). Vehicles deteriorate in service and this can have an adverse impact upon safety and the environment (Cuerden, et al., 2011). According to the National Highway Traffic Safety Administration (NHTSA), mechanical failure plays a significant role in the number of car accidents and injuries. In surveys of more than two million serious car accidents that occurred over a two-year period, maintenance issues that could have been avoided were responsible in over 40,000 cases (Anastopoulo, 2016). From the same source, the most common types of mechanical issues listed as a critical cause in car accidents and injuries include the following:

1. Tire problems, including blowouts and skidding due to worn tread
2. Brake issues, such as slow brake time and brake failure
3. Steering issues, such as pulling or loss of power steering
4. Transmission and engine issues, including slow acceleration and breakdowns
5. Suspension problems, such as vibrating and shaking which causes drivers to lose control of the vehicle

Also, as far as safety is concern, several studies have found out that tyre failure has impact on road traffic accident (Edunyah, 2016). An average driver uses the brakes about 75,000 times a year, making the brakes one of the most important (and overworked) parts of the car (McPhee & Johnson, 2007). However, a roadworthy vehicle may be defined as one in which there are no safety or emission related defects that would prevent the vehicle passing the periodic motor vehicle inspection in its country of use (Cuerden, et al., 2011).

2.3.11 Animals

Animals on the road frequently cause accidents and one potential risk of animals on the road is when a driver cannot stop in time to avoid an impact and instead swerves to miss the animal (Resqme, 2016). This can sometimes lead the vehicle to head off the road or to collide with a vehicle coming in the other direction. Even if the driver does not receive an injury, the vehicle can still be damaged beyond repair if such a collision occurs at speed.

More than 5,000 such accidents were recorded in New South Wales (NSW) in the decade between 1996 and 2005, resulting in more than 1,700 people being injured and another 22 killed when drivers collided with or tried to avoid animals, the study found (Beale, 2009). Also, in 2004 alone, about 700 wildlife-vehicle collisions (WVCs) were reported in the United State of America with collisions involving deer constituting the largest proportion.

2.3.12 Road Condition

According to the International Road Transport Union (2007) study, 5% of accidents are related to road conditions, but the road type has also an influence. Below is a list of some unsafe conditions of a road (Singh et al., 2015):

1. Bad Road Surface
2. Water/snow logging on roads
3. Obstacles on road
4. Debris on Road
5. Narrow and congested road
6. Improper road illumination
7. Pot Holes
8. Unmarked speed breakers
9. Overgrown trees and foliage on roads

In Mauritius**,** Motorway (M1) in Mauritius is considered to have the highest road accident death toll of all roads in the island and the locations of these accidents are spread over the whole stretch of the motorway (Statistics Mauritius, 2017). As from last year, the authority has taken drastic measures to mitigate severe accidents along the motorway.

2.3.13 Fear

A specific phobia of driving requires that a driver either avoid driving or riding as a passenger because of fear, or that the driving is tolerated with high levels of anxiety and fear (Koch, 2003). Driving anxiety and fear is reportedly common in motor vehicle crashes victims, although inconsistent definitions of what constitute driving fear and phobia have affected reports of incidence rates (Taylor, et al., 2007).

2.3.14 Fatigue and Stress

A range of psychological problems, including post-traumatic stress disorder, depression, fear and anxiety reactions can develop subsequent to a motor crash (Blanchard & Hickling, 1997).

Besides, road hazards are also an important factor to consider and could be among the main elements of road accidents.

2.4 Critical Analysis

Among the various causes of road accidents that have been presented above, this research study will investigate on the hazard perception skill of drivers. Driver hazard perception is an imperative driving ability that enables a driver to detect incoming collision risks within a complicated traffic environment (Borowsky, et al., 2012). A road hazard has been defined as another driver behaving erratically or a pedestrian incursion or an unexpected object in the driving path (Wells et al, 2008). As such, it is self-evident that hazard avoidance is a critical component with regards to safe driving and security of road users. In line with this perspective, Hazard Perception Test is an assessment that evaluates a person's ability to identify and respond to potentially dangerous road situations and to react appropriately. In particular, perception in driving terms can be defined as the art of being able to pick out the important details to enable a driver to anticipate to a developing hazardous situation and a perceptive driver must look for alternatives to avoid any unfortunate event. Therefore, it is of utmost importance for drivers to correctly identify road hazards within the appropriate time period in order to avoid a vehicular collision.

Chapter 3 – A Classification of Road Hazards

In the previous chapter, key causes of road accidents have been reviewed. Among these causes, poor hazard perception of drivers will be mainly investigated. With the growing number of road accidents in Mauritius, the inclusion of hazard perception test is becoming necessary since hazard perception training was found to significantly decrease the reaction time of drivers and thereby reducing road accidents. Hence, the following section will elaborate on the classification of road hazards and improving hazard perception of drivers.

3.1 Road Hazards

A hazard may be defined as anything that may require a driver to change speed, position or direction of the vehicle (Theory Test Advice, 2017). Hazards could include animals, rough roads, gravel, bumpy edges, expansion joints, slick surfaces, standing water debris, snow, ice and objects that have fallen from a construction site or another vehicle, among others. Whether a hazard is defined as another driver behaving erratically or a pedestrian incursion or an unexpected object in the roadway, it is self-evident that hazard avoidance is a critical component to safe driving and, conversely, that failures in responding appropriately to hazards increase driver risk (Scialfa, et al., 2010).

The Insurance Institute for Highway Safety (2010) reported that approximately 20% of all deaths in motor vehicle crashes involved fixed roadway hazards. Moreover, McKnight and McKnight (2003), found that among young drivers, more than 40% of crashes involved a failure to scan the roadway, presumably because scanning enables detection of hazards. Also, according to Quimby and Watts (1981), hazard response times decrease with age until the mid-50s. Therefore, in order to be adept at hazard perception, drivers must search the environment for potential hazards, often over prolonged periods of time while engaged in multiple distracting tasks (Scialfa, et al., 2010). In addition, they must have accurate expectations about when and where hazards are likely to occur, so that they can anticipate them and adjust their behavior accordingly. According to the Transport Roads and Maritime Services from the NSW Government, it takes time to develop hazard perception skills. The best way to achieve them is by getting plenty of driving experience across lots of different driving situations. A survey done by Sumer, Unal and Bridal (2015) where it was recorded that several actual real-life clips of the traffic, gathered a list of hazards captured as shown below:

3.2 Classifying Road Hazards

Therefore, it is a must to identify and classify hazard situations dynamically (Wetton, 2011). As listed in the previous section, many road hazards have been identified and it is important that the hazards should be grouped in categories for better analysis. The road hazards are prioritized as shown in **Error! Reference source not found.** below.

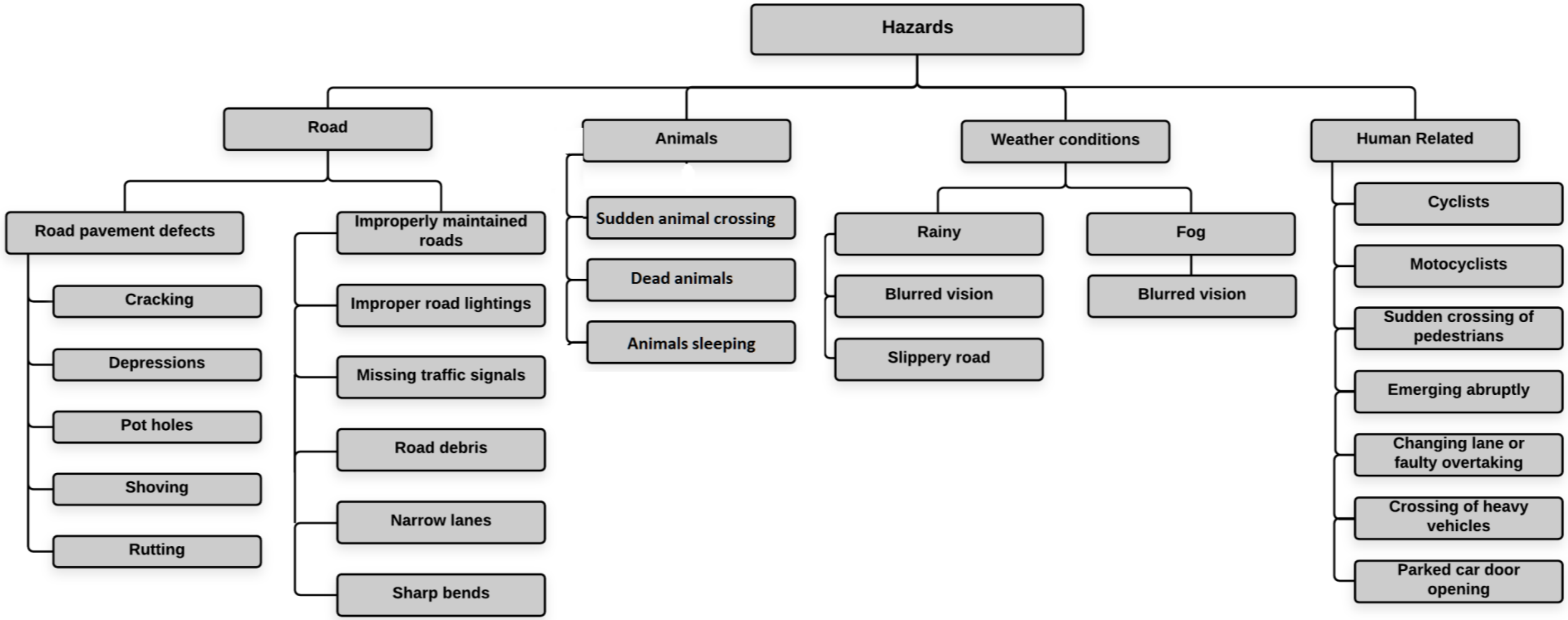

Figure 3.1: A taxonomy for road hazards

3.2.1 Road

The following subsections will discuss on the various types of road hazard that have been presented in the above hazard taxonomy.

3.2.1.1 Road Pavement Defects

Moreover, according to Adlinge and Gupta (2004), some road pavement defects such as alligator cracking, longitudinal cracking, pot holes, depressions, rutting and shoving are considered as potential hazards to road users. As such, the following sub-sections discusses these various types of road pavement defects:

3.2.1.1.1 Cracking

Alligator cracking commonly called fatigue cracking is a series of interconnected cracks creating small, irregular shaped pieces of pavement and it is caused by failure of the surface layer or base due to repeated traffic loading (Adlinge & Gupta, 2004). Besides, Longitudinal cracks are long cracks that run parallel to the center line of the roadway and these may be caused by frost heaving or joint failures, or they may be load induced (Adlinge & Gupta, 2004). Understanding the cause is critical to selecting the proper repair. Multiple parallel cracks may eventually form from the initial crack. This phenomenon, known as deterioration, is usually a sign that crack repairs are not the proper solution. Cracks are spalled and there may be several randomly spaced cracks near the main crack or at the corners of intersecting cracks (Moon, 2017).

3.2.1.1.2 Depressions

Depressions are small, localized bowl-shaped areas that may include cracking. Depressions cause roughness, are a hazard to motorists, and allow water to collect. Depressions are typically caused by localized consolidation or movement of the supporting layers beneath the surface course due to instability. Repair by excavating and rebuilding the localized depressions. Reconstruction is required for extensive depressions (Adlinge & Gupta, 2004).

3.2.1.1.3 Pot Holes

Pot holes are a normal part of the wearing process of a road and often form as fractures break the roadway and join together, eventually breaking away from the level surface of the road and leaving a hole after experiencing the weight of hundreds of vehicles (Abels & Annes, 2017). Potholes, often located in areas of poor drainage are bowl-shaped holes similar to depressions, are a progressive failure. First, small fragments of the top layer are dislodged. Over time, the distress will progress downward into the lower layers of the pavement (Adlinge & Gupta, 2004). However, some pot holes are large and pose an inherent danger to those in the area with the potential for creating collisions (Abels & Annes, 2017). Moreover, hitting potholes can even bend the rims of a car (Matheny & Pavelka, 2016).

3.2.1.1.4 Shoving

Shoving is also a form of plastic movement in the asphalt concrete surface layer that creates a localized bulging of the pavement. Locations and causes of shoving are similar to those for corrugations (Adlinge & Gupta, 2004).

3.2.1.1.5 Rutting

A rut is a longitudinal surface depression in the wheel path and it may have associated transverse displacement (Federal Highway Administration, 2003). Rutting is the displacement of pavement material that creates channels in the wheel path. Very severe rutting will actually hold water in the rut. Rutting is usually a failure in one or more layers in the pavement.

3.2.1.2 Improperly maintained roads

According to data provided by the Federal Motor Carrier Safety Administration, there are generally over 5,000,000 police-reported accidents each year. While these accidents can occur for a wide variety of reasons, each year some of the accidents are the result of improperly maintained or poorly designed roads (Levin Firm, 2014). Some key example of improperly maintained roads are discussed below:

3.2.1.2.1 Faulty/Missing traffic signals

Road signs are placed in specific areas to ensure the safety of drivers and to ensure smooth traffic flow without mishaps (Machuga, 2017). However, for a number of reasons, road signs seem to go missing or become damaged. Severe weather, car accidents and even theft are reasons why road signs need repair or replacement (Ibanez, 2012). Nonetheless, overuse, misuse and confusing messages of devices tends the drivers to ignore them (Mathew, 2017).

3.2.1.2.2 Road debris

Road debris includes everything from trash, pieces of tires, and other vehicle debris to household items or other consumer items that have fallen off a vehicle while in transport (Heiting & Irwin, 2016). When a vehicle cargo or a cargo part dislodges from a moving vehicle and falls onto the road, it becomes a serious hazard for road users. Even a small item may be dangerous when it is discharged at highway speed prompting erratic avoidance maneuvers, and causing a crash (Forbes & Robinson, 2004). This can include a mattress that flies out of a pickup truck, heavy furniture that was not tied down, woodchips or mulch that blow out of a truck bed in the wind, or a spare tire that bounces out of a vehicle that hits a bump in the road (Abels & Annes, 2017). Regardless of what the road debris may be, an accident caused by road debris is usually not the driver's fault but it may be difficult to determine who is at fault (Heiting & Irwin, 2016). In addition to that, low-hanging branches, dead trees and limbs, and trees too close to the road is equally a hazard to the traveling public and road users in general (Diffenderfer, 2017).

3.2.1.2.3 Narrow lanes

Road width has different mixed effects, for instance, when the road is perceived as wider, drivers increase speed, and thus the crash risk significantly increase (Fildes & Lee, 1993). However, the same authors state that narrowing lanes as a speed control countermeasure is not always recommended, otherwise the risk of head-on and run-off road crashes may increase. A field study evaluated the impact of lane narrowing with subsequent provision of a hard shoulder on driver behaviors on a rural road (Rosey, et al., 2009). This study gave two results. First, the lane narrowing with a wider hard shoulder had no influence on speeds and drivers traveled closer to the center of the lane. Second, the lateral position of the vehicle is largely influenced by oncoming vehicles. Rasanen (2005), found in a field study that drivers steer closer to the edge line when meeting oncoming traffic. Thus, on narrow roads, drivers can either collide with an oncoming vehicle on the opposite lane or drift toward the road edge when meeting a larger vehicle such as a truck. Besides, accidents at the bends had been very frequent, despite appropriate warning signs and road-markings. Fortunately, only a very small proportion involved injury, because lack of crash barriers or other road side obstacles resulted in most vehicles coming to rest with only minor damages (Stewart & Cudworth, 1990).

3.2.2 Animals

Ever since the advent of the automobile during the early years in the 20^{th} century, wildlife casualties on roads have received particular public as well as scientific attention (Helldin & Seiler, 2006). Animal-vehicle collisions such as sudden crossing, sleeping animals and dead animals are a major issue for traffic safety and despite the measures applied to reduce the conflict, the numbers of accidents involving wildlife are still increasing in many European countries. (Rosell, 2013).

Economically, these accidents have also high impact through vehicular damage (Morelle, et al., 2013).

3.2.3 Weather Conditions

The following discusses on the climactic conditions that have been illustrated within the road hazard taxonomy.

3.2.3.1 Rainy

Rain is a natural phenomenon that comes at its season, or at any other time (Edet, 2017). In the year 2001, Los Angeles County had 60,204 fatal and injury accidents on the road, 2,716 of which occurred during wet weather, according to the California Highway Patrol (Martin, 2002). Therefore, only about 5% of all fatal and injury accidents in the county took place in the rain. According to Edet (2017), below are the two main hazards of rainfall.

3.2.3.2 Blurred vision

The rain acts like a lens which scatters lights and distorts the visual scene image (Marc, 2013). Active rainfall reduces vision and is a risk factor which could result to accident (Edet, 2017). Rain affects ability to see through the car windshield and even with wipers operating, the splashing of rain periodically block vision (Marc, 2013).

3.2.3.3 Slippery Road

Following a rainy condition, the water accumulation on the road causes a loss of friction. As tires move over a wet surface, the water fills in the tiny pits in the road surface, effectively smoothing out the surface. As a result, the normal heat and friction created is decreased, leading to a surface that is more slippery as compared to when dry (Wonderopolis, 2017).

3.2.4 Human Related

The next subsections will discuss on the different types of human related hazard that have been presented in the road hazard taxonomy

3.2.4.1 Cyclists and Motorcyclist

Riders have less stability and crash protection than in a car and irrespective of who is at fault, the motorcycle or the bicyclist will more than likely to suffer worst in a collision with a vehicle (Road

Safety Authority, 2009). Crash prevention is relatively more important for vulnerable road users such as pedestrians, bicyclists and motorcyclists who are not protected by a vehicle body and related vehicle safety features (Haworth & Mulvihill, 2006). Moreover, any person who rides a cycle on a road without due care and attention, or without reasonable consideration for other persons using the road, shall commit an offence (Director of Public Procecutions, 2003). Highlighting Government's concern over the alarming rate of road accidents, including fatal ones, the Prime Minister of Mauritius in 2015 said that a new system for the issue of driving licence to motorcyclists will be put in place by the Ministry of Public Infrastructure and Land Transport. It was also listed that the measures being implemented by the Police to curb road accidents. They comprise sensitisation sessions on road safety and causes of road accidents, roll over simulator to stress the importance of using seat belts, road block operations and installation of speed cameras around Mauritius (Government Information Service, 2015).

The number of cyclist fatalities has decreased by only 3 % which is much lower than the total fatality decrease of 18 % from 2010 to 2013 in the European Union and one possible reason for the slow reduction of the number of cyclist victims is that the total number of cyclists goes up as more people turn to more sustainable and healthy transport modes (European Commission, 2015). In a survey conducted, over half the people questioned replied that they do not cycle, with the main reasons being concerned around the safety of road cycling and about drivers treating them badly (RoSPA, 2015). The most recent figures reveal that 23,326 motorcyclists (including moped and scooter riders) and pillion passengers were injured in reported accidents in Great Britain in 2006. Of the injuries sustained, 5,885 were considered serious and 599 motorcyclists and passengers were killed. Deaths among motorcycle users accounted for 19% of fatalities in 2006 and 9% of all road traffic casualties were motorcyclists (Department for Transport, 2005). Per billion miles cycled, 1,025 pedal cyclists are killed or seriously injured, in comparison to 309 car drivers (RSPA, 2017). Moreover, the age profile among motorcyclist fatalities is almost the opposite that of pedestrians and cyclists. Only 4% of all killed motorcyclists were older than 65 years. 57% were between 25 and 49 years (European Commission, 2015).

3.2.4.2 Pedestrians

Road traffic crashes kill about 1.24 million people each year (World Health Organization, 2013). The first recorded pedestrian fatality by car occurred in the year 1896 where when a man named Bridget Driscoll stepped off of a London curb was struck and killed by a gas-powered Anglo-French model car driven by Arthur Edsall (Soniak, 2012). The same author stated that while the car had a top speed of four miles per hour, the driver was not able to avoid the collision. Pedestrian fatalities on motorways are mostly linked to accidents at roadwork sites or to crashes where car occupants are injured when stepping out of the car (European Commission, 2015). The share of elderly is also higher among the pedestrian fatalities than among the total road deaths and around 44 % of all killed pedestrians were 65 years or older (European Commission, 2015). The 15-24 year olds make up only 8% of the pedestrian fatalities. Pedestrians are most vulnerable road users and more than 270,000 pedestrians lose their lives on the world's roads annually. Globally, pedestrians make up 22% of total road death toll and in some low and middle income countries this proportion is high up to two third (Klair, 2017). Pedestrian collisions, like all road traffic crashes, should not be accepted as inevitable because they are, in fact, both predictable and preventable (World Health Organization, 2013). However, at some time or another, every driver is a pedestrian and traffic laws are written for both driver and pedestrian, according to (Ivey, et al., 2016), below is a list of actions that drivers and pedestrians should consider:

Drivers must:

1. Yield the right of way to pedestrians.
2. Not pass (overtake) another vehicle stopped for pedestrians in a crosswalk.
3. Stop for students and school safety patrols directing the movement of children.
4. Yield to blind pedestrians carrying a white or metallic cane, with or without a red tip, or using a guide dog when such blind person enters an intersection of any street, alley or other public highway.
5. Not block crosswalks when at a stop sign or waiting on a red light.
6. Stop for a school bus displaying an extended stop arm.
7. Exercise extreme care to avoid hitting a pedestrian.

Pedestrians must:

1. Obey traffic control signals at intersections.
2. Use sidewalks where provided and usable.
3. Walk on the left side of the roadway giving way to oncoming traffic.
4. Yield to all vehicles when crossing at points other than within a marked crosswalk or in a crosswalk (extension of the sidewalk) at an intersection.
5. Not stand in the roadway while hitchhiking.

3.2.4.3 Vehicle emerging abruptly

Collisions at junctions are not one of the most common types of claims, but they tend to be more serious and higher cost, and they are all associated with human error (Zurich, 2015). Emerging is a skill which requires a lot of practice to be able to consistently judge the speed and distance of approaching vehicles. Also, gap selection is important and it shouldn't cause other drivers to brake, swerve or hit the car (Cottingham, 2010). According to Zurich (2015), the following are some of the more common contributory factors of collisions at junctions:

1. Failure to adapt to the prevailing road conditions
2. Inappropriate speed
3. Driving whilst distracted
4. Poor observation
5. Poor anticipation
6. Driver Fatigue
7. Poor vehicle maintenance

3.2.4.4 Faulty overtaking / Vehicle changing lane abruptly

One of the simplest ways to understand fault determination is to consider what rules or regulations may have been broken that were a cause of the accident (Insurance Hotline, 2013). Overtaking is one of the most risky manoeuvres on the road (Automobile Association of Singapore, 2016). When someone fails to properly check before changing lanes or merging, or is following too close and thus collides another car, or drifts over the center line, that person has made an error in judgment and driving inability that results in an accident; that person is thus at fault (Insurance Hotline, 2013).

3.2.4.4 Large Vehicles

Large vehicles have larger blind spots where it is difficult for car drivers to see the road clearly. Additionally**,** Allardice's (2002) list of hazardous road configurations includes a number of situations that reflect the hazards associated with the behavior of other road users and are as follows:

1. Roundabouts and intersections (other vehicles may fail to give way)
2. Traffic lights (possible rear-end crashes and red-light runners)
3. Motorways (high speeds close to "disinterested, inattentive, impatient, stressed and distracted vehicle drivers")
4. Bridges (no escape route from potential head-on collisions).

3.2.4.5 Parked car door opening

Liability is the least of the worries when one considers the threat to life and limb in these situations (Wallace, 2014). One of the biggest risks to bike riders is car doors being opened into their path and the bike rider may swerve out further into the road or collide with the car door, often with serious consequences (Victoria State Government Roads, 2017). According to the same source, between July 2011 and June 2016 in Melbourne, there were 771 car doorings involving bike riders where two were fatalities and 177 were serious injuries. Many drivers have been hit because they exited a vehicle quickly without first checking traffic. Crashes of this kind can often result in a total loss and write-off of a vehicle (Wallace, 2014).

Chapter 4 - Reducing Road Accident Risk through Improved Hazard Perception Skills

4.1 Reducing Risks of Accidents

A road accident refers to any accident involving at least one road vehicle, occurring on a road open to public circulation, and in which at least one person could be injured or even face death (Insee, 2016). The Statistics of Mauritius (2017) defines road accident as an accident between two or more vehicles, a vehicle and a cyclist, a vehicle and a pedestrian, a vehicle and a fixed object such as a bridge, building, tree, post, etc, or a single vehicle that overturned on or near a public road. According to the same source, there are 4 main types of severity of accidents which are fatal, serious, slight and non-injury road accident.

1. **Fatal road accident**

   Fatal accident is an accident resulting in the death of one or more persons. During January to June 2017, among these accidents, 69 were fatal (caused death) against 68 registered during the corresponding period of 2016 (Statistics Mauritius, 2018).

2. **Serious road accident**

   A serious road accident is one in which one or more persons are seriously injured.

3. **Slight road accident**

   A slight accident is one in which one or more persons are slightly injured.

4. **Non-injury road accident**

A non-injury accident is road event in which no one is killed or injured but which results in damage to the vehicle/s and/or other property.

4.2 Hazard Perception

Driver hazard perception is considered as a vital driving ability that allows drivers to detect impending collision risks within a complicated traffic environment (Borowsky, et al., 2012). Thus from this perspective, it is important for road users to identify hazards in an appropriate time frame so as to avoid a vehicular collisions. One of the common way to measure the hazard perception of a driver is to ask them to observe computer-based traffic-scene filmed from a driver's perspective and to press a response button each time they detect a developing hazard. As such, the following sub-sections provide the co-relationship between hazard perception and accident involvement.

Whether a hazard is defined as another driver behaving erratically or a pedestrian incursion or an unexpected object in the roadway, it is self-evident that hazard avoidance is a critical component to safe driving and, conversely, that failures in responding appropriately to hazards increase driver risk (Wells et al, 2008). Therefore, to reduce road accidents, the introduction of a hazard perception skill could be added from the beginning before a driver is going to the practical driving car test.

4.3 Relevance of Hazard Perception Skill in Accident Involvement

Hazard perception (HP) is the process of detecting, evaluating and responding to dangerous events on the road that have a high likelihood of leading to a collision (Crundall et al., 2011). Perception in driving terms can be defined as the art of being able to pick out the important details to enable a driver to anticipate what is likely to happen next in a particular situation and a perceptive driver must look for clues and build up a mental picture of what may happen next (Theory Test Advice, 2017). An example of a hazardous situation is displayed in Figure 4.1.

The situation is developing and experienced drivers may have noticed the cyclist (red circle).

The cyclist is now clear, as is an approaching car. A hazardous situation has developed, and the test taker should have responded.

It is now too late to respond; the hazardous situation has fully developed.

Figure 4.1: Example of a Hazardous Situation

Moreover, in order to drive safely, one needs to develop and maintain a large number of complex perceptual and cognitive skills (Scialfa, et al., 2010). Included in this skill set is the ability to quickly and accurately identify hazards in the driving environment. Additionally, according to the previous source, the development of hazard perception has taken on a great sense of importance recently because hazard perception has become a compulsory part of the licensure process in the U.K. and in most Australian states (Horswill & McKenna, 2004).

For example, Pradhan et al. (2005) presented novice and experienced younger drivers with simulated scenes in which there were potential hazards with no obvious cue. Compared to more experienced young drivers, novices were much less likely to fixate critical areas in the scenes. Since experience is critical to the development of any skill, it is not surprising that practice can mitigate novice deficits in hazard perception (Scialfa, et al., 2010). In addition, training may have direct benefits for skills, and may also provide indirect benefits by creating safer attitudes in new drivers, who often believe they are better than average drivers (Wells et al, 2008). The four component model shown in Figure 4.2 was developed by Grayson et al. (2003) which shows the processes involved when responding to risk on the road. The model has four components which are as follows:

1. Hazard Detection – being aware that a hazard may be present
2. Threat Appraisal – evaluating whether the hazard is sufficiently important to merit a response
3. Action Selection – having to select a response from one’s repertoire of skills
4. Implementation – performing the necessary actions involved in the response that has been selected.

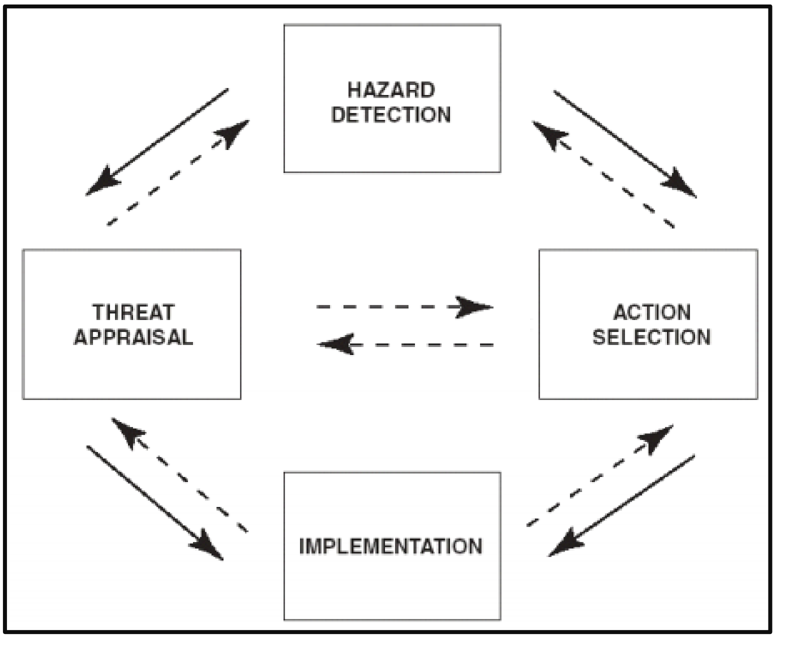

Figure 4.2: Responding to a risk process

(Source: Grayson et al., 2003)

Much of the research in hazard perception and hazard perception training has focused on young novice car drivers (Grayson et al., 2003). The research has demonstrated that their hazard perception skills are poorer than older, more experienced drivers. Also, it has shown that hazard perception training can improve their performance on hazard perception tests to a level similar to older, more experienced drivers.

4.4 Mechanisms to Improve HPS amongst Drivers

The primary objective of any automotive driver-licensing test is to determine whether the driver is capable of driving safely on public roads (Wetton, 2011). Though common hazards as described in section 3.1 could be included in every HPT, every country has its own hazards in particular. Moreover, there exists several Hazard Perception tools to assess the skills of detecting hazards of drivers as discussed in the next section.

According to (Wetton, 2011), a HPT test offers several advantages over on-road tests:

1. All applicants can be assessed using the same set of hazard scenarios (or alternative forms of the test known to have comparable psychometric properties);
2. Neither applicants nor assessors are exposed to any personal risk; and
3. Responses to hazards are measured objectively by capturing actual response times, rather than having assessors provide subjective evaluations of performance.

4.5 A Comparative Analysis of HPS Tools

There are various existing web and mobile based Hazard Perception Skills Tools to train future or existing drivers on how to be aware of a hazard present on a road. However, each tool will have different additional features though its main priority is to train a road user to increase the hazard perception skill.

4.5.1 Web Based Hazard Perception Tools

The following sub-sections will present an overview of the various existing web based hazard perception tools that are currently being used to asses an individual's hazard perception level.

4.5.1.1 Hazard Perception Test

The hazard perception test is part of the UK theory test[1] administered by the DVSA (Driver and Vehicle Standards Agency) and takes place straight after the multiple-choice section of the test. This platform offers free mock tests, a detailed guide about how the hazard perception test works and tips for passing the test.

However, as a premium member, a user would have access to the following features from the web application:

- 6 Full-Length Tests
- 10 CGI Video Clips
- 120 Real Life Video Clips

4.5.1.2 Hazard Perception Test in Australia

This HPT[2] gives a taste of the skills needed to pass the hazard perception test. Each time a user start practicing, the latter gets 7 random questions from a sample of 34. Also, clips of real driving situations are displayed and the user is asked to respond to these situations using mouse clicks.

4.5.1.3 Theory Test Online – Hazard Perception Test

The Theory Test Online[3] starts by a video explaining how the hazard perception test works and what a user is required to do. After the tutorial, the user is shown 14 hazard perception video clips of about one minute each. On each clip, there will be 2 developing hazards to find and a total 15 hazards are expected to find on all of the hazard perception clips.

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[1] UK theory test by the DVSA (Driver and Vehicle Standards Agency)
http://hazardperceptiontest.net/

[2] Hazard Perception Test in Australia
http://mylicence.sa.gov.au/hazard-perception-test

[3] Theory Test Online
https://www.theory-test-online.co.uk/theory-test/hazard-perception-test.htm

4.5.1.4 Theory Pass – Hazard Perception Test

The Theory Pass[4] test contains 14 video clips, each showing an everyday road scene. Out of the 14 clips, 13 of them contain one developing hazard and the remaining clips contains two. Depending on the reaction time of the user towards the developing hazards shown, a score up to 5 points per hazard can be obtained.

4.5.1.5 Driving Test NSW

Driving Test NSW[5] provides a range of free resources and it focuses on an effective preparation, and on the criteria for success in the Hazard Perception Test. Moreover, the platform provides practice tests, study tips, test tips, test details and license details.

4.5.2 Mobile based Hazard Perception Tools

The next sub-sections provide an overview of the various existing mobile based hazard perception test tools that are currently being used to asses an individual's hazard perception level.

4.5.2.1 Hazard Perception Test Free 2017 – Focus Multimedia Ltd (Driving Test Success)

It provides 8 free interactive hazard perception clips with official DVSA content. The application is developed for car drivers, motorcyclists, trainee ADIs, LGC and PCV drivers. As features, the application provides the following:

- Each clip with professional voiceover to improve understanding of how each hazard develops.
- A cheat detection rule is built that replicates the official DVSA test.
- A detailed progress monitor is available so that to let the candidate know when the test is ready.
- No internet connection is needed.
- Free support is provided.

A paid version of the same application is also available where 75 videos with more hazards are included and additional features are provided. Below are the additional features:

- A user is able to practice 10 official DVSA clips
- Each clip is reviewed
- Provides a mock test that simulate the DVSA test.

[4] Theory Pass – Hazard Perception Test
https://theorypass.co.uk/hazard-perception/
[5] Driving Test NSW
http://www.drivingtestnsw.com/hazard-perception-test-hpt-resources

4.5.2.2 Hazard Perception Test 2017 - Ketbilietai

With approximately 50,000 downloads, the mobile application aims to recognize, respond to developing hazards on roads and teach essential skills needed to pass the test. As a trial version, it provides 8 free interactive videos with Official DVSA contents. However, to have access to more videos, a user needs to purchase the updated version of the application.

The mobile application is designed for:

- Learner Car Drivers
- Learner Motorcyclists
- Trainee LGV (Large Goods Vehicle) Driver
- Passenger Carrying Vehicle (PCV) Drivers

As key features, the application provides the following:

- Practice and obtain immediate feedback after each clip to know the result.
- Reviewing each result to know where the maximum points could have been scored.
- Progress monitor to keep track of the candidate.
- Works without internet.

4.5.2.3 Theory Test and Hazard Perception – Deep River Development Ltd (Paid Version)

The paid application includes car driving theory test and Hazard Perception Test Preparation Modules featuring 42 official DVSA and unique custom made Hazard Perception revision videos.

The main features that the application provides are as follows:

- An anti-cheating mechanism which checks if the number of clicking is inappropriate.
- Provides mock theory tests as many times a user wish to participate.
- Select different videos containing different hazard for the test.
- A comprehensive statistics average score.

4.5.2.4 Hazard Perception Free UK

The application contains 20 official revision clips from the DVSA for the United Kingdom which helped over 1 million learners to prepare for their tests.

As key features the application comes with the following:

- Receive immediate feedback after each clip for a user to know the score
- Review each clip to know where the hazard was present and how maximum score could have been scored.

- Gain experience with different types of hazards
- Progress monitor to track how a candidate is performing.

Most of the web and mobile based HPT tools identified are mostly commercial versions where a user needs to pay to have access to more videos and participate in a test which contains more hazards. Slow retrieval of a clip is also an issue that slows down the process of conducting a test. Among those HPT tools identified, there is not yet an HPT platform developed for Mauritius. Nonetheless, even though the current driving test includes assessing the identification and reacting to hazards on roads, the candidate is not always exposed to all sorts of hazards in a 30 minutes of driving test. Besides, to be exposed to the number of hazards contained in a traditional computer-based hazard perception, a driver would have to endure tens of hours of on-road testing (Wetton, 2011).

Although the stated HPT tools above could be used for aspiring drivers in Mauritius or for existing drivers to increase their hazard perception reaction, the hazards present in the videos are not similar and are not specifically developed according to the Mauritian road condition. Hazard Perception Tools should be specifically designed for a particular country which has its own common hazards. Therefore, there is a huge necessity to develop a similar interactive HPT tool to assess the hazard perception skills especially for Mauritius citizens. Hence, for this project, a web-based hazard perception tool that could easily integrate the driving test for candidates in Mauritius was developed and evaluated. In particular, the web-based tool was preferred as there were already existing similar applications developed and which could take reference in order for the HPT tool to be more efficient and user friendly. In addition, the web-based approach was also chosen due to availability of open source tools and platform to support the development process. Besides, making use of a web-based application would equally allow both flexibility and extensibility to mobile platforms thereby increasing accessibility.

Chapter 5 Analysis and Design

5.1 System Requirements

In this section, the system requirements are presented. The system requirements can be categorised into functional and non-functional requirements. Functional requirements define the capabilities and functions that a system should be able to successfully perform, while the non-functional requirements define the qualities and criteria that can be used to judge the operation of the system (Chung, et al., 2012).

5.1.1 Functional requirements

Functional requirements define the core functions of a particular system. It usually expresses the inputs and outputs that the system is required to execute (Zhou, 2004).

The format chosen to illustrate the functional requirements is as follows:

ID: *The identification number of a particular requirement.*

Description: *Specification of the requirement.*

Explanation: *A brief explanation about the specified requirement*

The system's functional requirements are listed in **Error! Reference source not found.** below:

ID	Description	Explanation
FR01	Users must be able to register to use the system.	The user must be able to sign up filling out a form with his username, email and password.
FR02	Users must be able to log into the system.	The system will allow authorized users to login using their valid username and a password.
FR03	Users must be able to logout from the system at any time.	The system will provide a "logout" button in the main menu for users to safely exit from the system.

FR04	The system must provide an informative message if wrong input details are entered during the registration or login process.	An error message will be displayed to the user in case wrong credentials details are entered during the registration or login process.
FR05	Users must be able to select different languages.	The system will provide a dropdown with three different languages options.
FR06	Users must not be able to seek videos.	The system will be designed so that users are not able to view videos prior to any particular test.
FR07	Users must click on start to initiate any video.	The system will provide a 'start' button before the beginning of any video.
FR08	Unregistered users must be able to do tutorial.	The system should allow users to undertake/view a selected tutorial.
FR09	Registered users must be able to tutorial and test.	The system should allow registered users to take both tutorials and hazard perception test.
FR10	Users must be able to click on the video with regards to a developing hazard.	The system should show a response after each click made by the user in response to a developing hazard.
FR11	The system must have an access panel for authorised administrator.	The system will provide an interface where the system admin can set various test and its difficulty level.

Table 5.1: Functional Requirements

5.1.2 Test-Case for Functional Requirements

Table 5.2 below describes the test case for validating the functional requirements as pre-defined in the above section. The test case mainly consists of the specification of the functional requirement, test plan, test data (input-details) and the expected result after performing the respective test.

Test Case ID	Functional Requirement	Functional Test Plan	Test Data	Expected Result
TC 01	Users must be able to register to use the system.	Enter valid sign-up details in the registration form.	"Enter a username, first name, last name, valid email address password, address and driving license date"	The user is added to the system with all the specified details.
TC 02	Users must be able to log into the system.	Enter valid input details in the login form.	"Enter a valid username and password"	The user is redirected to the test webpage.
TC 03	Users must be able to logout from the system at any time.	Press on the “logout” button in the homepage.	Not applicable	The user is logged out and is redirected to the login interface.
TC 04	The system must provide an informative message if wrong input details are entered during the registration or login process.	Enter invalid input details in the login form	"Enter an invalid username and password"	An informative message will be displayed to the user if invalid credentials details are entered
TC 05	Users must be able to select different languages.	Select another language from the home page	Not applicable	The user is able to view contents of the web

				application in the selected language
TC 06	Users must not be able to view any videos before taking tutorials or tests.	Navigate on the website without taking tutorial and test	Not applicable	The user is not able to view any videos
TC 07	Users must click on start to initiate any video.	click on 'tutorial' in the home page and then click on 'start' button	Not applicable	The user is able to view the video after clicking on the start button
TC 08	Unregistered users must be able to do tutorial.	Without registering on the system, click on 'tutorial' in the home page	Not applicable	Any user is able to take a tutorial
TC 09	Registered users must be able to tutorial and test.	Upon registering on the system, click on 'test' from the home page.	Not applicable	Registered users are able to take tutorial and test.
TC 10	Users must be able to click on the video with regards to a developing hazard.	Click on 'start' button to initiate a video and then click on the video to response to a developing hazard	Not applicable	The user is able to view a response from the system once an action is performed to a developing hazard

Table 5.2: Functional Requirement Test Case

5.1.3 Non-Functional requirements

Non-functional requirements state how the application operates. These include the design constraints, performance and qualities that affect the architecture of the system (Malan & Bredemeyer, 2001). Below some important classes of the non-functional requirements are presented based on their importance and relevance to the proposed system:

1. **Usability**: It refers to the ease to which users can learn to operate, specify inputs, and interpret outputs of the system.

2. **Flexibility**: It refers to the ability of the system so as to easily exchange information with a range of users.

3. **Reliability:** It refers to the ability of a system to perform its required functions under various conditions during a specific time period.

4. **Modifiability/Extensibility**: It refers to the ability of the system to be easily changed in order to accept new requirements.

5. **Security:** The system must be equipped with credentials requirements.

6. **Performance**: It refers to the speed of operation performed by the system.

The system's non-functional requirements are described in Table 5.3 below:

ID	Description	Explanation
NFR01	The graphical user interface must be easy enough for users to accomplish their task and all screens should be consistent.	The buttons, menus and layouts should have a similar style so as to allow users to navigate easily without having major difficulties.
NFR02	The system should clearly display notification messages to the user.	The system should display messages in the form of pop-up windows with detailed information after each operation made by the user. For example, after adding details in registration form.

NFR03	The system should inform users about every wrong input details or operation.	An error recognition message will be displayed to the user to inform them about any wrong input details or operation which has been performed.
NFR04	The system should request a password for each user account.	The system will not display the available features to a user unless he or she logs in to his/her account.
NFR05	The system should have a fast response time.	The system should perform all its operations very fast. If operations needs time to be executed, then a spinning loader will be displayed to the user.
NFR06	All videos in the system should have a video resolution of 720 pixels.	The system will be designed to support video having 720 pixels or above.
NFR07	The system should disable all videos sound.	The system will be designed where all video will be muted.
NFR08	The system must be designed in order to accept new features and operations.	The system must be designed systematically so that any developer can add new features and operations to the source code.

Table 5.3: Non-Functional Requirements

5.2 Use-case Diagram

In software and systems engineering, a use case is a list of steps which defines the interactions between actors and a system so as to accomplish a specific goal/task. An actor is a person, organization or external system that plays a role in one or more interactions with the system (Alexander & Maiden, 2005).

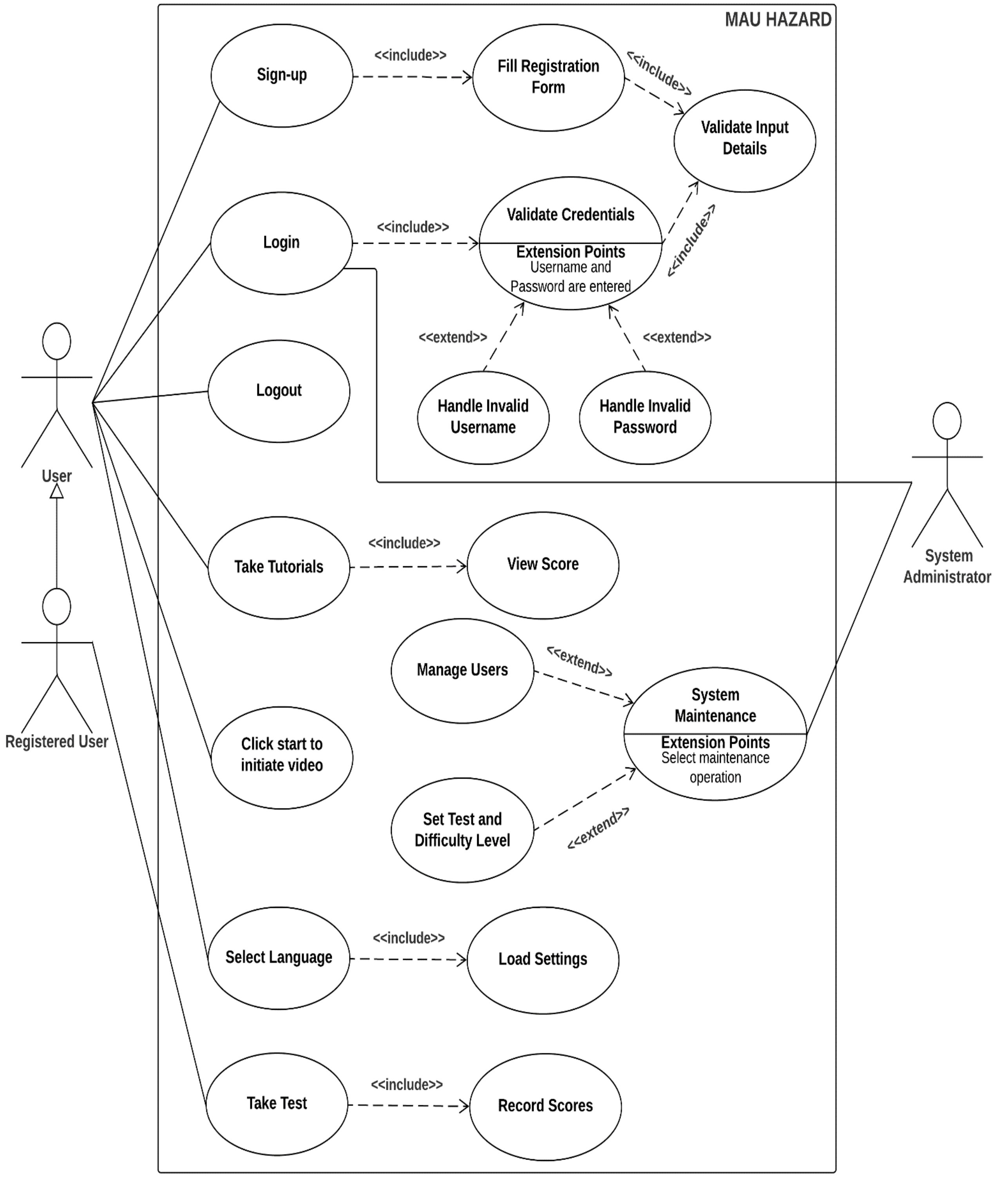


Figure 5.1: Use-case Diagram

5.2.1 Use-case scenario

The tables below shows the use-case scenario for each use-case involved in the use-case diagram as presented in. The use-case scenario in Table 5.4 below describes the way a user registers into the system for the first time.

Use Case Name	**Sign-up**
Primary Actor	User
Trigger	User wants to create an account
Pre-condition	The user has not yet been registered on the system
Post-condition	The user becomes registered and holds a valid account
Main Success Scenario	1. The user enters his or her username, email and a password 2. The user presses on the *"Add"* button 3. The system checks if the username and email address entered is valid 4. The system checks if the password entered is valid 5. The system registers the new user with the specified parameters such as username, email address and password

Table 5.4: User Registration

In Table 5.5 below the use-case scenario describes the way a user logs into the system.

Use Case Name	**Login**
Primary Actor	User
Trigger	User wants to log into the system
Pre-conditions	The user has already created an account The user has not yet logged into the system
Post-condition	The user is logged on and has access to all the features in the system

Main Success Scenario	1. The user enters his or her username and a password 2. The user presses on the *"Login"* button 3. The system checks if the specified login details are valid 4. The system allows the authorized user to access the homepage in a new session

Table 5.5: User Login

In Table 5.6 the use-case scenario describes the way a user logs out from the application.

Use Case Name	**Logout**
Primary Actor	User
Trigger	User wants to log out from the system
Pre-conditions	The user is logged on and the system is running
Post-condition	The user is successfully logged out from the system
Main Success Scenario	1. The user presses on the "Logout" button in the home page 2. The system terminates the user's session and logs him/her out from the system

Table 5.6: User Logout

In Table 5.7 the use-case scenario describes the way a user takes a tutorial.

Use Case Name	**Take Tutorials**
Primary Actor	User
Trigger	User wants to take a tutorial
Pre-conditions	The user is logged on and the system is running
Post-condition	The user is able to successfully take a tutorial

Main Success Scenario	1. The user presses on the “tutorial” link in the home page 2. The system displays a new page to the user having three different categories of tutorial 3. The user then select the level of difficulty he or she wants to undertake.

Table 5.7: User takes a tutorial

In Table 5.8 the use-case scenario describes the way a user takes a test.

Use Case Name	**Take Tests**
Primary Actor	User
Trigger	User wants to take a test
Pre-conditions	The user is logged on and the system is running
Post-condition	The user is able to successfully take a test
Main Success Scenario	1. The user presses on the “test” link in the home page 2. The system displays a new page to the user with the test guidelines 3. The user then takes the test after reading the instructions.

Table 5.8: User takes a test

5.3 Class Diagram

A class diagram is commonly used to illustrate a static view or blueprint of a system where it defines the various methods, relationships and variables that are present within an object (Bennett, et al., 2010). In general, class diagrams are extensively utilized in the modelling of object-oriented programming where it directly maps with the different object-oriented languages such as Java, C++ and among others. As such, figure 5.2 below display the class diagram of the proposed system.

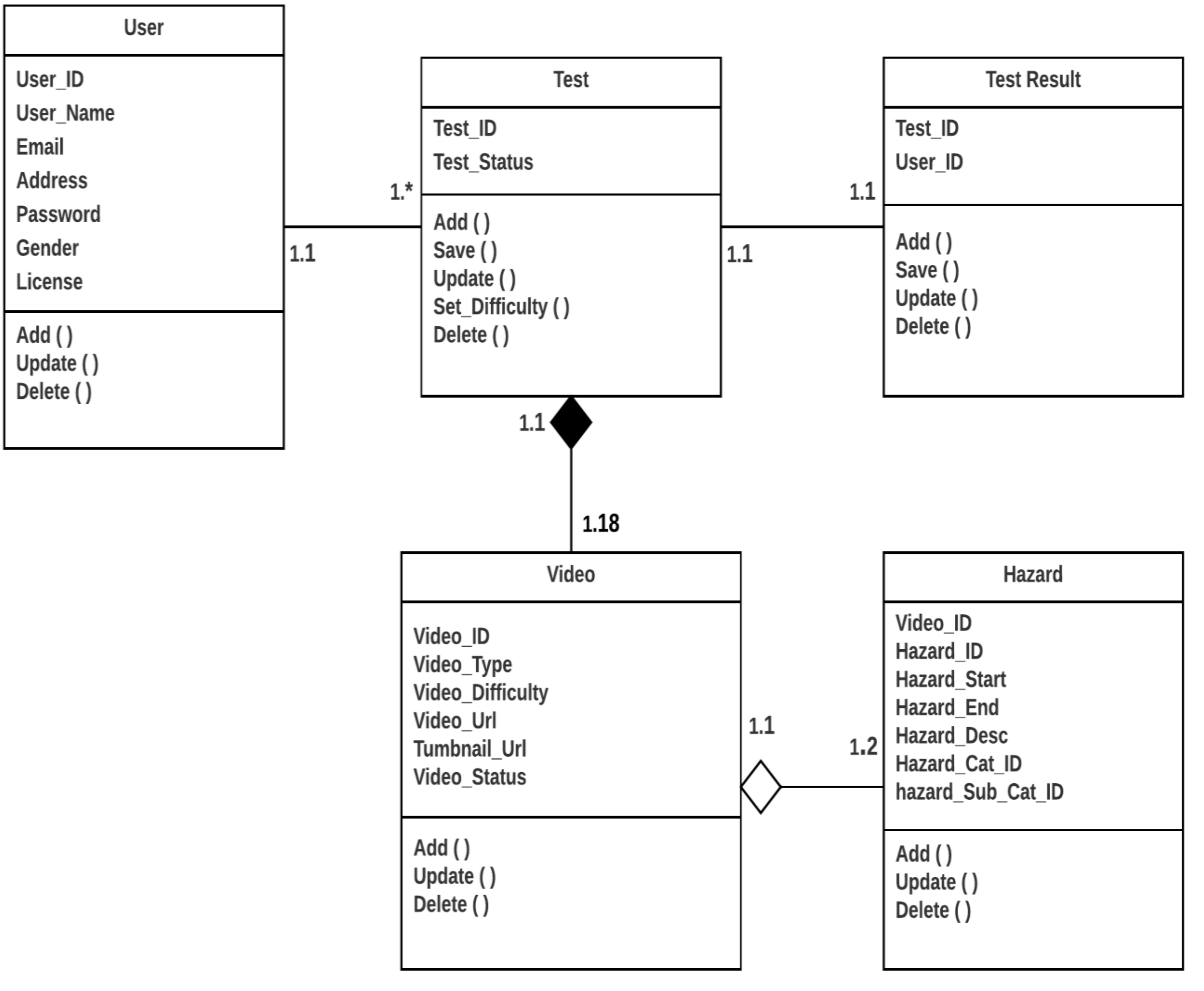


Figure 5.2: Class diagram

As presented above in figure 5.2, the class diagram indicates the relationships between different objects. For example, a particular user can take one or many test(s) showing a one-to-many relationship. Also, when a particular class is dependent on another class, it is commonly denoted by a filled diamond which depicts a composition relationship. As shown in the class diagram, the 'video' class also known as the composition class has no independent existence if the 'test' class is not instantiated or created.

5.4 Collaboration Diagram

A collaboration diagram is a graphical representation which is used to model the different relationships and interactions between various objects in a particular system (Abdurazik & Offutt, 2000). In general, the objects within the collaboration diagram are instances of classes that are present in the class diagram. As such, figure 5.3 below shows the collaboration diagram illustrating the different processes that are involved when taking a test on the proposed system.

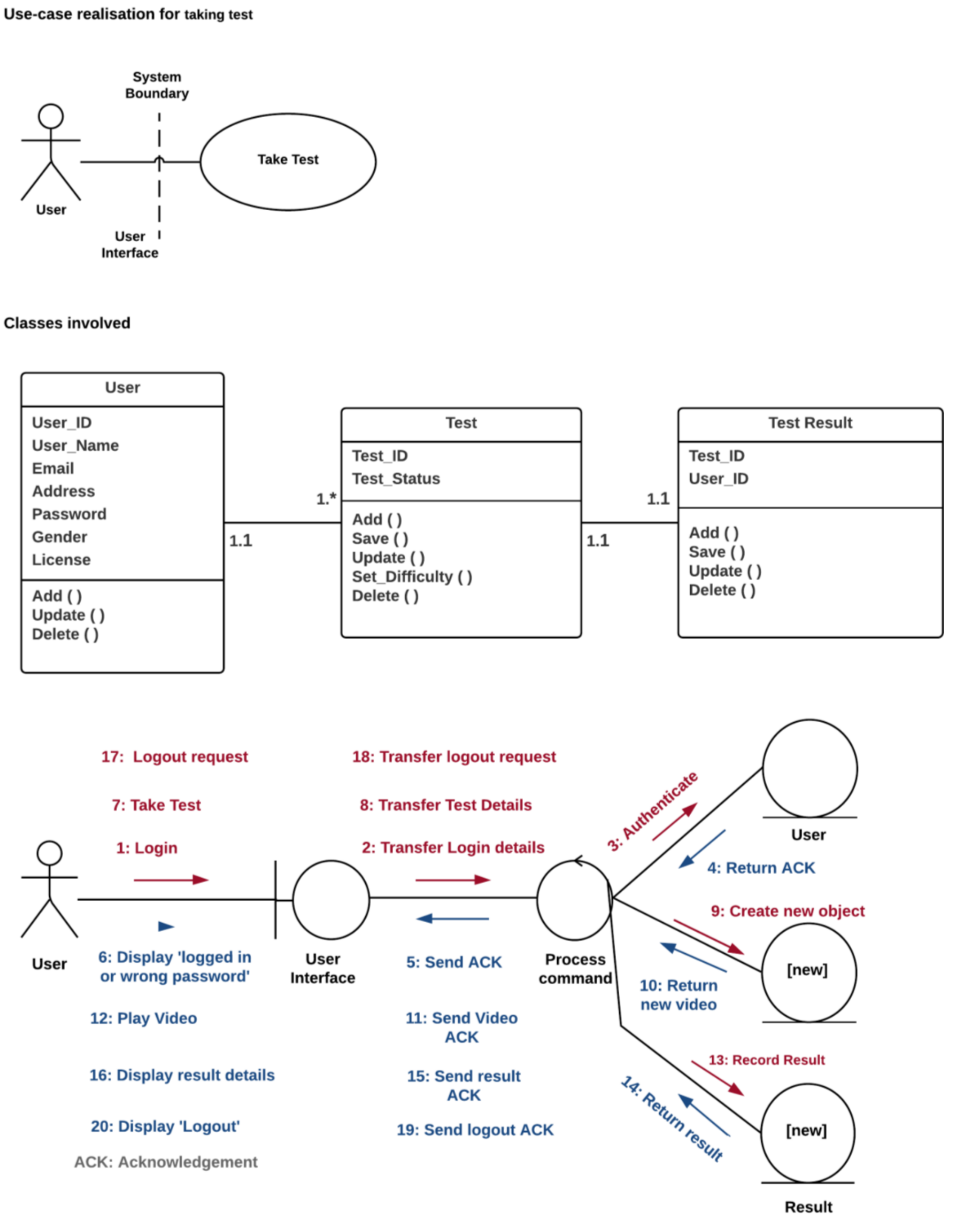


Figure 5.3: Collaboration diagram for taking hazard perception test

5.5 Sequence Diagram

Sequence diagrams are essentially used to illustrate a dynamic view of the various interactions between objects in a sequential order together with the different exchange of messages that occurs over a given time period. Figure 5.4 below shows the sequence diagram for the scenario the way a user takes a test through the use of the proposed system.

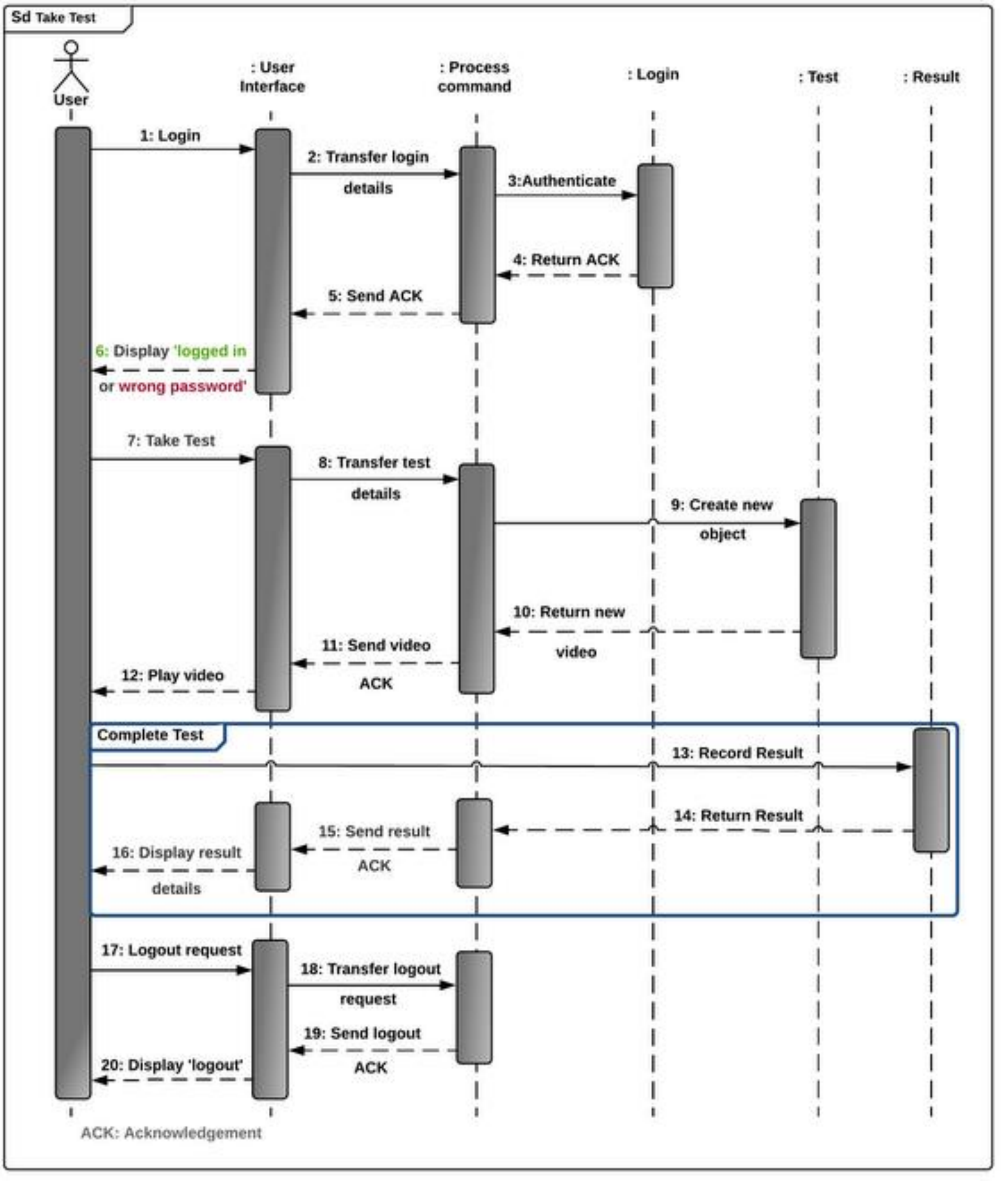


Figure 5.4: Sequence diagram for taking hazard perception test

5.6 Logical Database Design

Figure 5.5 below displays the web application's logical database model. The database structure essentially consists of five entities (tables) named as User, Test, Result, Video and Hazard. The table 'User' stores all the personal details that are specified by the user during the registration process. The table 'Test' stores all the test details which the user will undertake, while the table 'Result' will record the score of a particular test made by the user. Moreover, the table 'Video' contains all the clips for the test and the table 'Hazard' stores all the hazard details for each clip. In addition, each of these tables has a distinct identifier that a holds a unique value and is depicted as the primary key. For instance, in the table 'User' each user has a unique identification number denoted as 'UserId'.

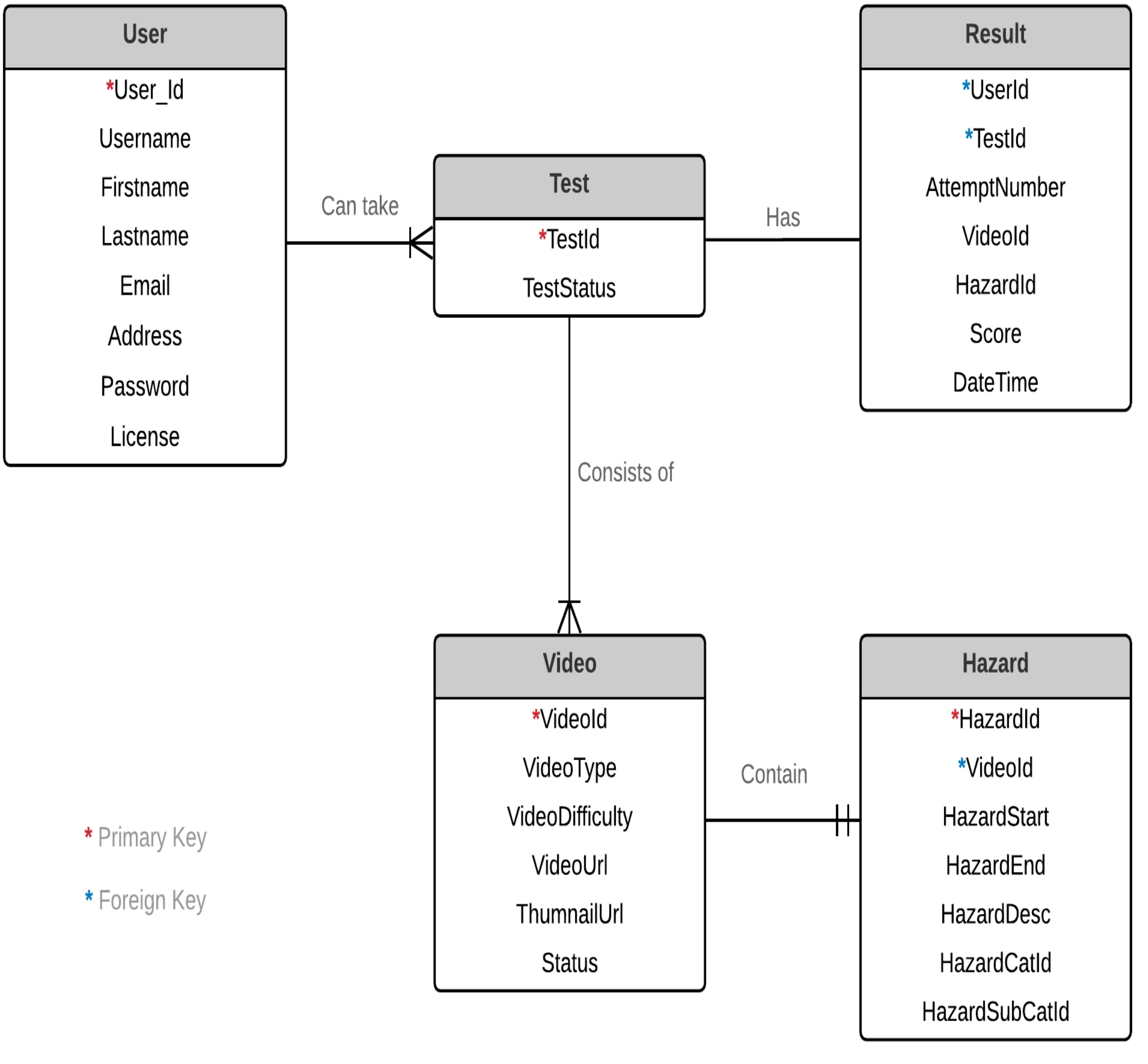


Figure 5.5: Logical database design

5.7 User Interface Design

The different screen layouts for the proposed web application were designed after analysing some of the imperative usability heuristics that have been recommended by Jakob Nielsen for User Interface design (Nielsen, 1995). As such, Table 5.9 below lists the different usability heuristics that have been taken into consideration while designing the various screen interfaces for the proposed web-based application.

Usability Heuristics For User Interface Design	
Usability Heuristics	**Description**
Visibility of the system status	The system should constantly inform the user about its updates in a timely manner
Similarity between the system and the real world	The system should always communicate in the languages and concepts that are interrelated within the real world and are easily understandable by most users
Freedom and user control	The system should support undo and redo functionalities. Users usually select functions by mistake and consequently they require an immediate action to avoid difficulties.
Consistency and proper standards	Follow platform standards and made easy to understand. System to be designed should meet standards conventions
Prevention of errors	Users must be asked with confirmation options before any actions are taken to avoid problematic situations
Recognition rather than ability to remember	Information must be retrievable without users having major search difficulties (Visibility of instructions)
Flexibility and efficiency of use	Both experienced and inexperienced users must be able to appropriately use the system without facing any hindrance
Aesthetic design	Dialogue boxes or pop-up windows must be simple and specific
Help users recognize, diagnose and recover from errors	Error messages must be presented in understandable languages where it defines the problem accurately and constructively recommends for a possible solution
Documentation and Help	A concise user manual should be readily available whenever needed by the user

Table 5.9: Usability heuristics for User Interface design
(Source: Nielsen, 1995)

5.7.1 Registration Screen Design

Figure 5.6 below shows the registration screen design that will allow a user to register into the system by entering his or her personal details such as name, email address, password, gender and driving license information.

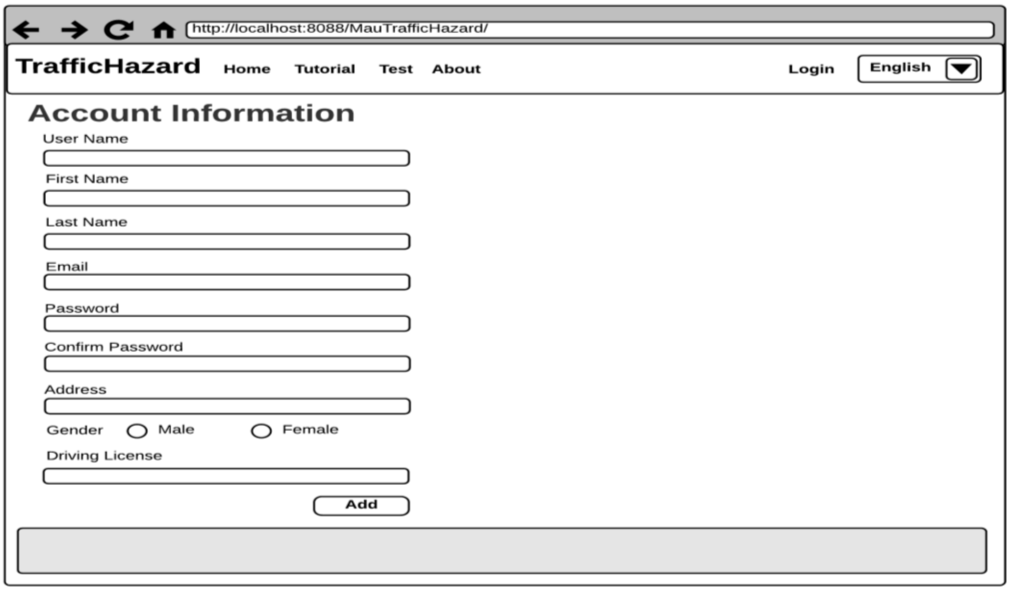


Figure 5.6: Registration Screen Design

5.7.2 Login Screen Design

Figure 5.7 below displays the login screen design that will allow an authorized user to log into the web application by using a valid username and password.

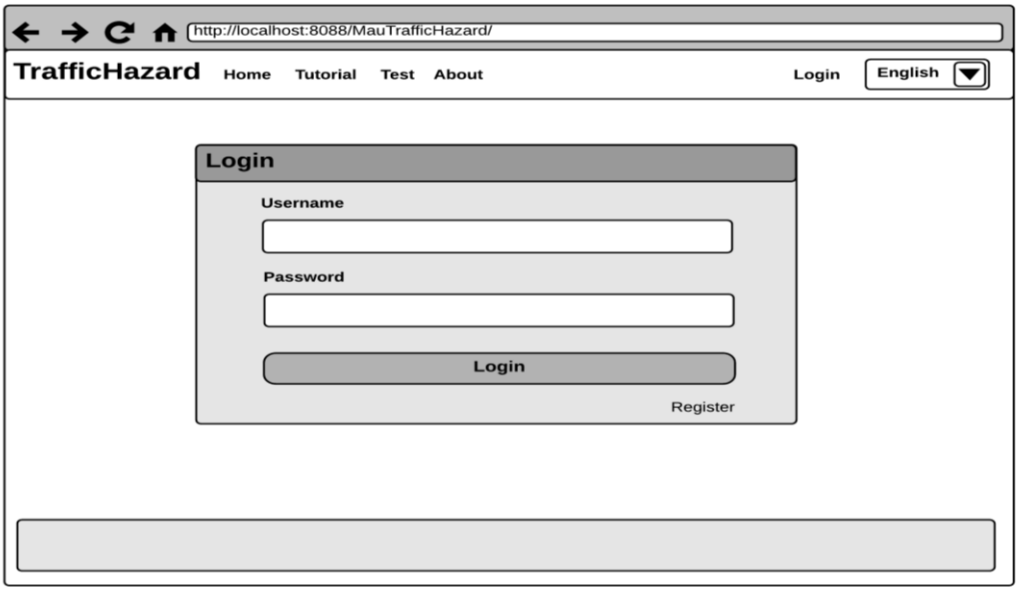


Figure 5.7: Login Screen Design

5.7.3 Home Page Screen Design

The screen design in Figure 4.8 below will essentially enable a user to have access to all the features that are available within the web application. Besides, the interface will also contain all the information related to hazard perception as well as the aim of the tool.

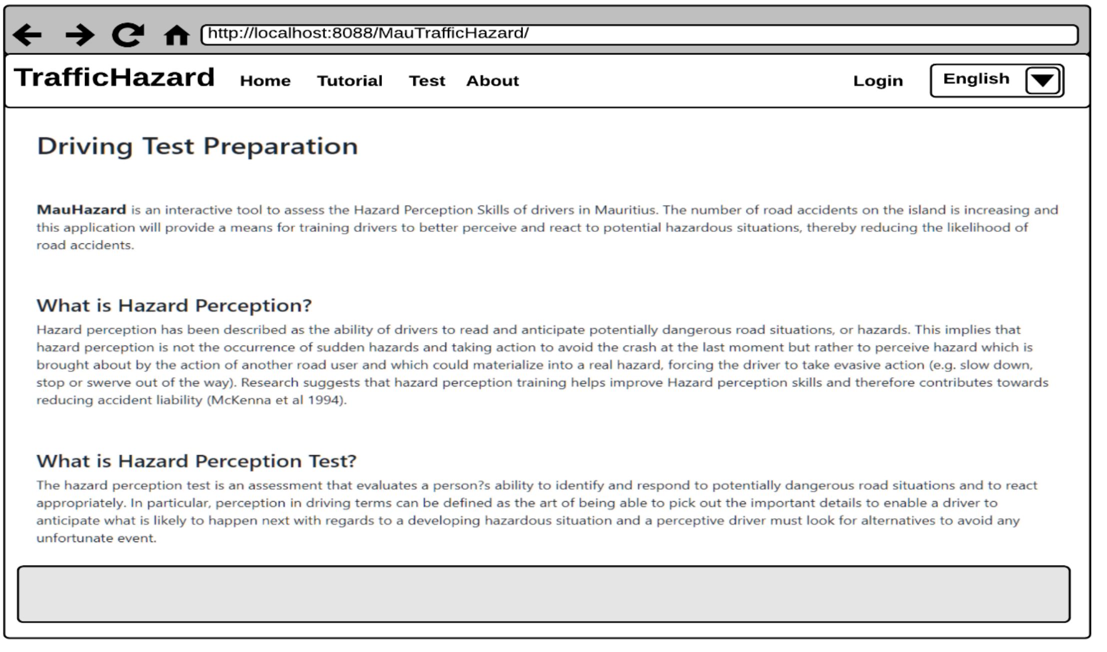


Figure 5.8: Home Page Screen Design

5.7.4 Tutorial Screen Design

The screen design as shown in Figure 5.9 below will allow users to take tutorial on hazard perception test. This interface will principally provide information on the instructions related to hazard perception test, hazard descriptions and scoring details.

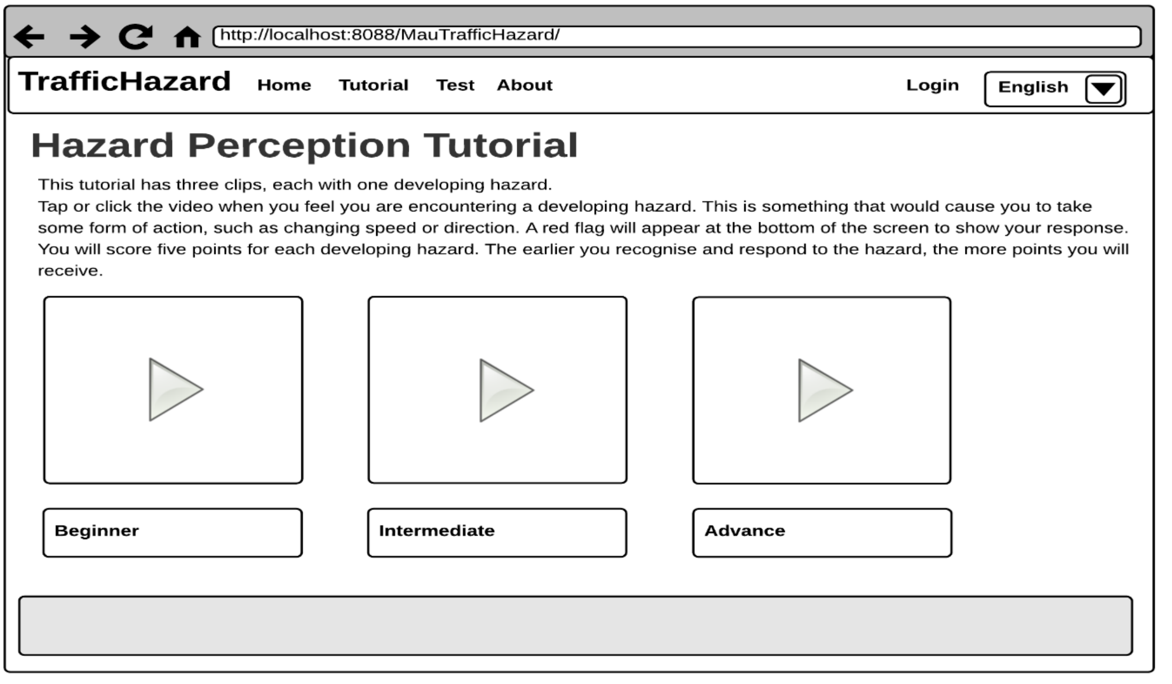


Figure 5.9: Tutorial screen design

5.7.5 Test Screen Design

The screen design as shown in Figure 5.10 below will allow authorized users to take the hazard perception test.

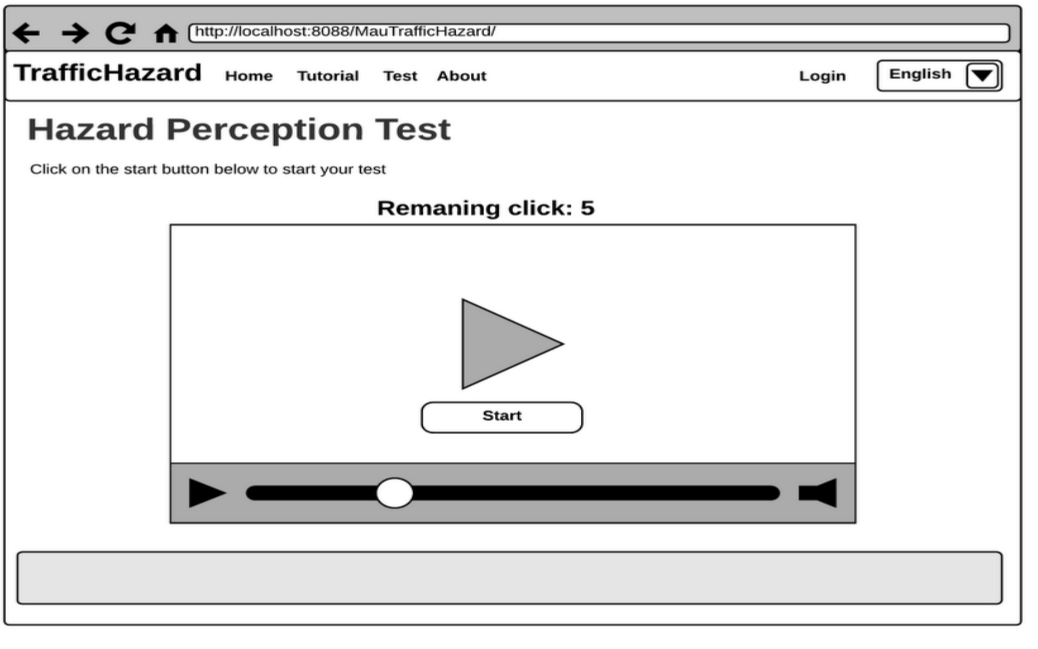


Figure 5.10: Test screen design

Chapter 6 Implementation and testing

6.1 System Development

The web application 'Mau Hazard' was developed using the Spring Framework integrated development environment, which is an open source platform that provides comprehensive infrastructure support for developing Java-based applications (Johnson, et al., 2014). In particular, the Spring Framework as shown below in Figure 6.1 is made up of 20 modules and are grouped into Core Container, Data Access, Web Aspect Oriented Programming, Instrumentation and test.

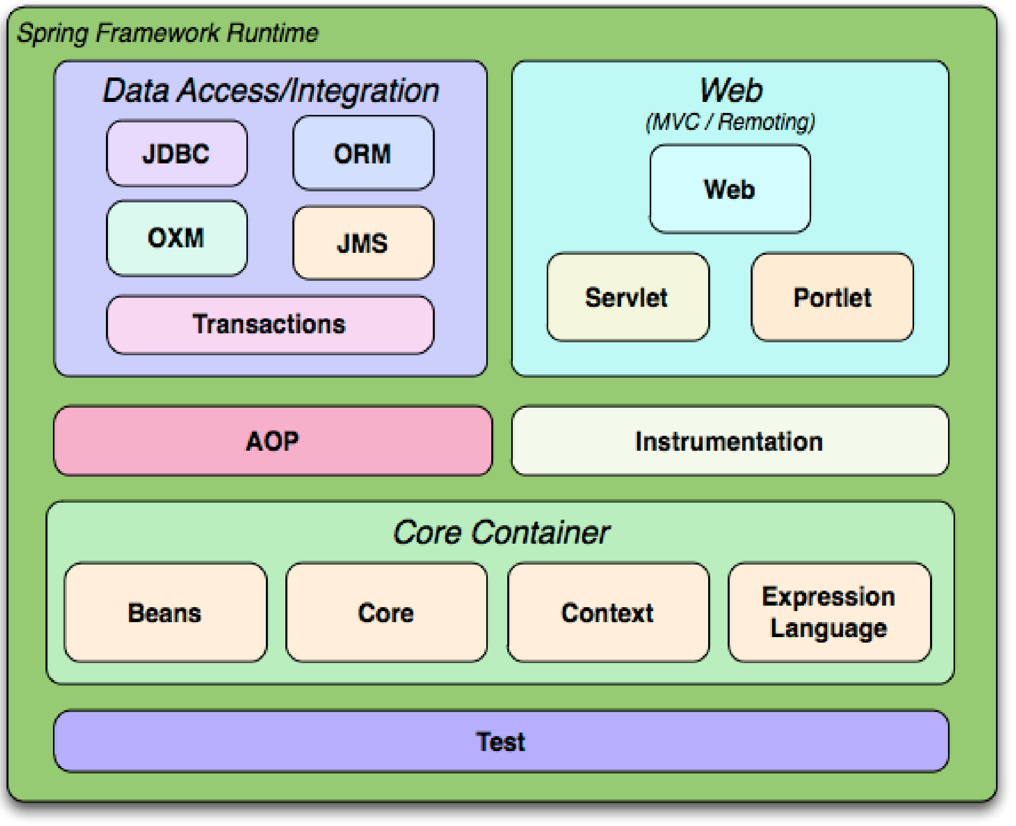


Figure 6.1: Overview of Spring Framework

(Source: Johnson, et al., 2014)

Essentially, the web module is fundamentally based on the Spring's Model-View-Controller (MVC) architectural structure that provides a clean separation between the domain model code and web forms making a logical way of representing the various components within the web development framework. In addition, the MVC is an important programming paradigm where the model represents the access point to raw data and is often used to retrieve information from a database. The view represents the component that displays information to the user and usually forms the overall layout of the applications, while the controller interconnects the view to the model.

6.2 Project Structure

The project structure consists of various project files that are important for the development of the proposed web-based 'Mau Hazard' application. As such, Figure 6.2 below displays all the project folders that were involved in the development of 'Mau Hazard' application.

Figure 6.2: Overview of project structure

6.3 Model

Listing 6.1 below illustrates part of the model component for creating different tables in the local data store (MySQL database). For instance, the personal details of a particular user such as their username, first name, email address and password are stored in the "user" table and are requested from this table using respective retrieve methods.

UserDaoImpl.java | User.java

```java
package com.mau.hazard.model;

public class User {
    Integer id;
    String name;
    String lname;
    String fname;
    String email;
    String address;
    String password;
    String confirmPassword;
    String sex;
    String license;
    Integer active;
```

List of attributes for the user class

```java
    @Override
    public void save(User user) {

        KeyHolder keyHolder = new GeneratedKeyHolder();

        String sql = "INSERT INTO USERS(username, fname, lname, email, address, password, gender
                + "VALUES ( :name, :fname, :lname, :email, :address, :password, :sex, :license,

        namedParameterJdbcTemplate.update(sql, getSqlParameterByModel(user), keyHolder);
        user.setId(keyHolder.getKey().intValue());

        sql = "INSERT INTO USER_ROLES(roleuserid, username, role)"
                + "VALUES(:userid, :username, :role)";

        MapSqlParameterSource paramSource = new MapSqlParameterSource();
        paramSource.addValue("userid", user.getId());
        paramSource.addValue("username", user.getName());
        paramSource.addValue("role", "ROLE_USER");
        namedParameterJdbcTemplate.update(sql, paramSource);

    }
```

Methods that save information in the tables found in the database

Listing 6.1: Extract of the details for maintaining database

6.4 View

The view is essentially represented by Java Server Pages commonly known as JSP which is a technology that helps in creating dynamically generated web pages based on Hypertext Markup Language (HTML). As shown below, Listing 6.2 displays the HTML elements and attributes which have been used to design the login screen interface.

```
<!DOCTYPE html>
<html lang="en">
<body>
<jsp:include page="header.jsp" />
<spring:url value="/users/register" var="urlRegister" />
<c:url var="loginUrl" value="/login" />

        <div id="mainWrapper">
        <div class="container">

            <div class="row">
            <div class="col-md-6 mx-auto">
                    <span class="anchor" id="formLogin"></span>
            <!-- form card login -->
                    <div class="card rounded-0">
                        <div class="card-header">
                            <h3 class="mb-0">Login</h3>
                        </div>
                        <div class="card-body">
                            <form action="${loginUrl}" method="post" class="form" role="form" autocomplete="off" id="formLogin">
                                <c:if test="${param.error != null}">
                                <div class="alert alert-danger">
                                    <p>Invalid username and password.</p>
                                </div>
                                </c:if>
                                <c:if test="${param.logout != null}">
                                    <div class="alert alert-success">
                                        <p>You have been logged out successfully.</p>
                                    </div>
                                </c:if>
                                <div class="form-group">
                                    <label for="uname1">Username</label>
                                    <input type="text" class="form-control" name="ssoId" id="uname1" placeholder="Enter Username
                                </div>
                                <div class="form-group">
                                    <label>Password</label>
                                    <input type="password" name="password" class="form-control" id="pwd1" placeholder="Enter Pas
                                </div>
                                <input type="hidden" name="${_csrf.parameterName}"  value="${_csrf.token}" />

                                <button type="submit" class="btn btn-primary btn-block">Login</button>
                            </form>
```

Defining the root element for the login screen interface

This action tag (jsp: include) is used to add resources to make a dynamic page

Defining a container within the HTML document to perform specific tasks

Contains the different child elements, attributes and validations tags that creates the login form

Listing 6.2: Extract of the login screen interface

6.5 Controller

The controller consists of various methods that are used to link the user interface (view) to the model. Listing 5.3 below displays an extract of the various methods that were used as part of the home page for the proposed web application.

```
*HomeController.java
package com.mau.hazard.controller;

import java.util.ArrayList;

/**
 * Handles requests for the application home page.
 */
@Controller
@SessionAttributes({"attempt"})
public class HomeController {

    @Autowired
    private VideoService videoService;

    @ModelAttribute("attempt")
    public int getAttempt(){
        return 0;
    }

    private static final Logger logger = LoggerFactory.getLogger(HomeController.class);


    @RequestMapping(value = { "/", "/home" }, method = RequestMethod.GET)
    public String homePage(ModelMap model) {
        model.addAttribute("greeting", "Hi, Welcome to mysites");
        return "welcome";
    }

    @RequestMapping(value = "/admin", method = RequestMethod.GET)
    public String adminPage(ModelMap model) {
        model.addAttribute("user", getPrincipal());
        return "admin/admin_home";
    }

    @RequestMapping(value = "/db", method = RequestMethod.GET)
    public String dbaPage(ModelMap model) {
        model.addAttribute("user", getPrincipal());
        return "dba";
    }
```

"ArrayList" allows all Java Core Libraries to be called rather than calling each library one by one

Creating a controller class called HomeContoller which will be dedicated for the homepage

@ Request Mapping is a keyword which is used to map the dispatcher servlet with the controller class.

The GET request method is used to get the requests from the user and to output results into a view (interface).

Listing 6.3: Extract of methods for home page

6.6 Screen Layouts of The Implemented System

6.6.1 Registration Screen

Figure 6.3 below shows the registration screen layout that will essentially enable a user to log into the system by entering his or her personal details such as name, email address, password, gender and driving license information.

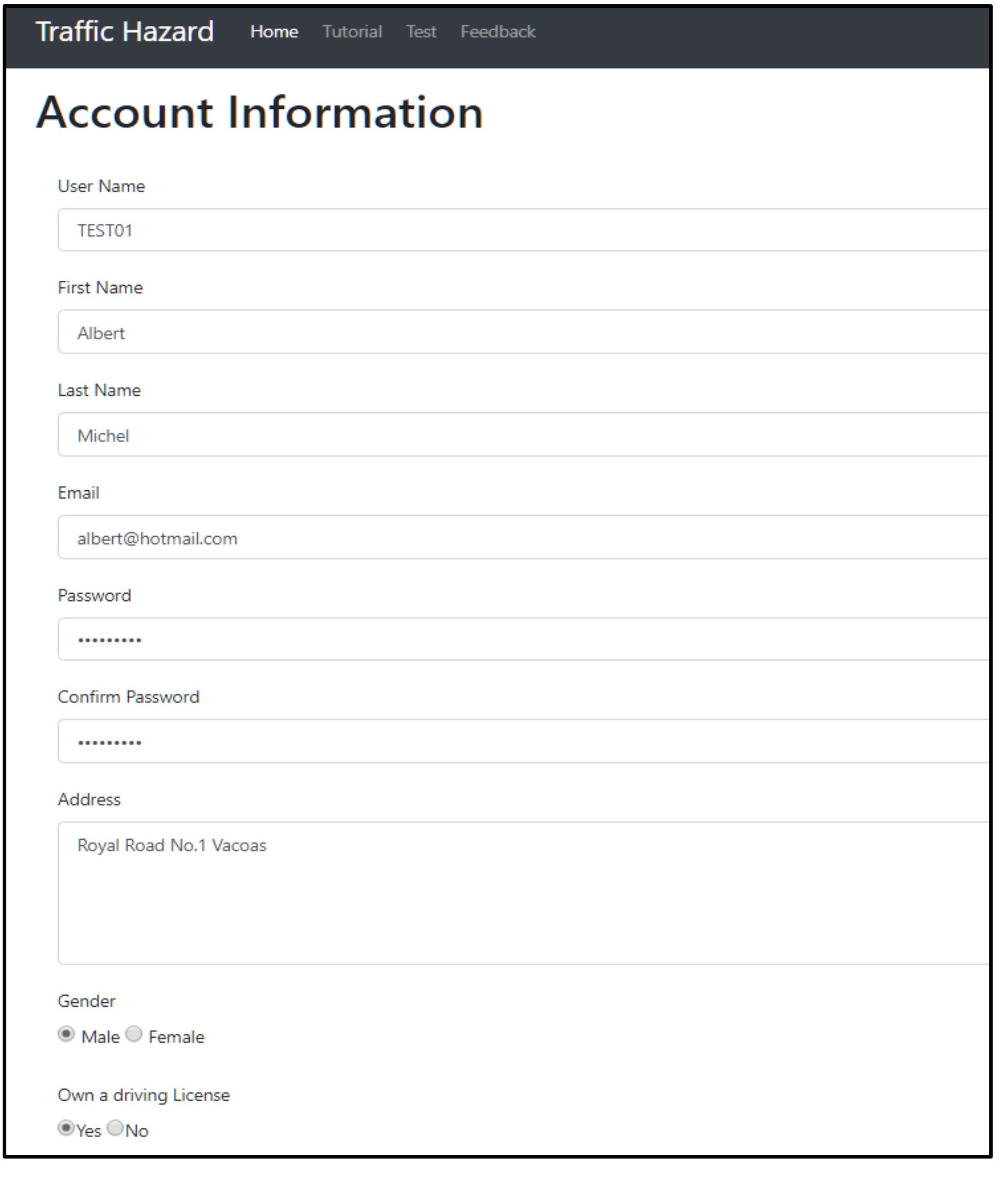


Figure 6.3: Registration screen layout

6.6.2 Login Screen

Figure 6.4 below displays the login screen layout that will allow an authorized user to log into the web-based application using his or her valid username and password.

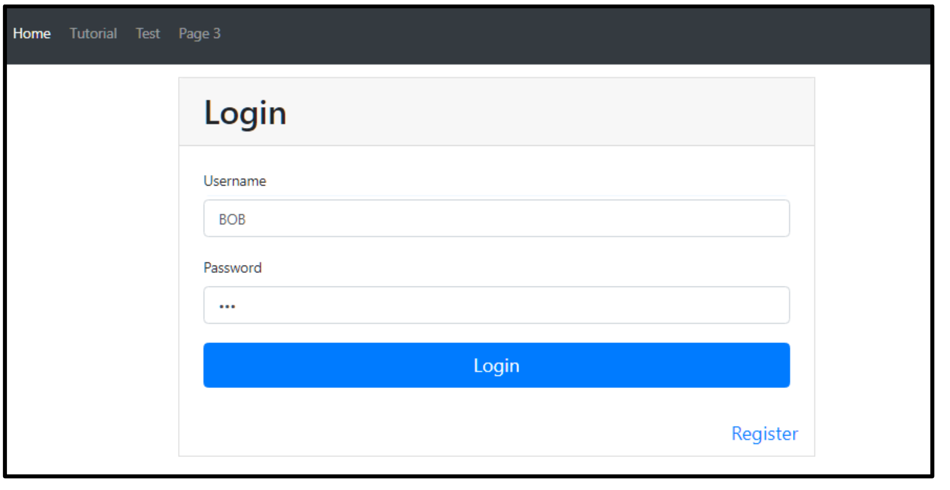


Figure 6.4: Login screen layout

6.6.3 Home Screen

The screen layout below in Figure 6.5 displays the home page of the web application where users can find important information relating to hazard perception.

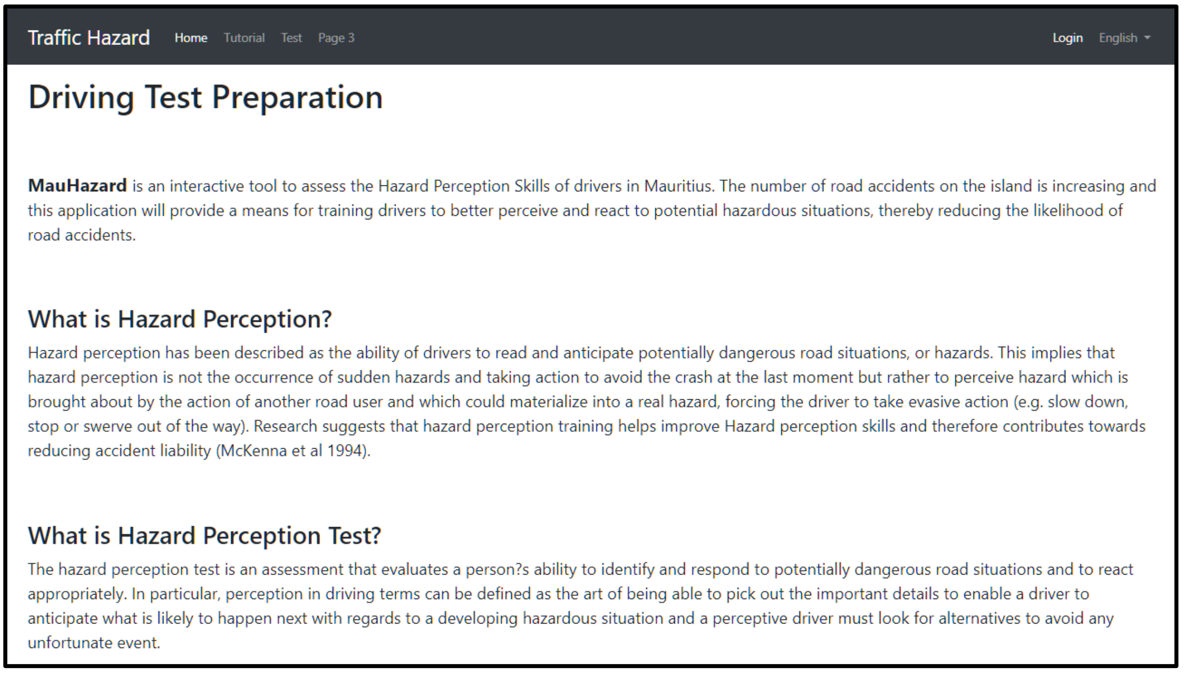


Figure 6.5: Home screen layout

6.6.4 Tutorial Screen

Figure 6.6 below shows the tutorial screen layout that will allow a particlar user to take a lesson on the hazard perception test along with a description of the hazard detials.

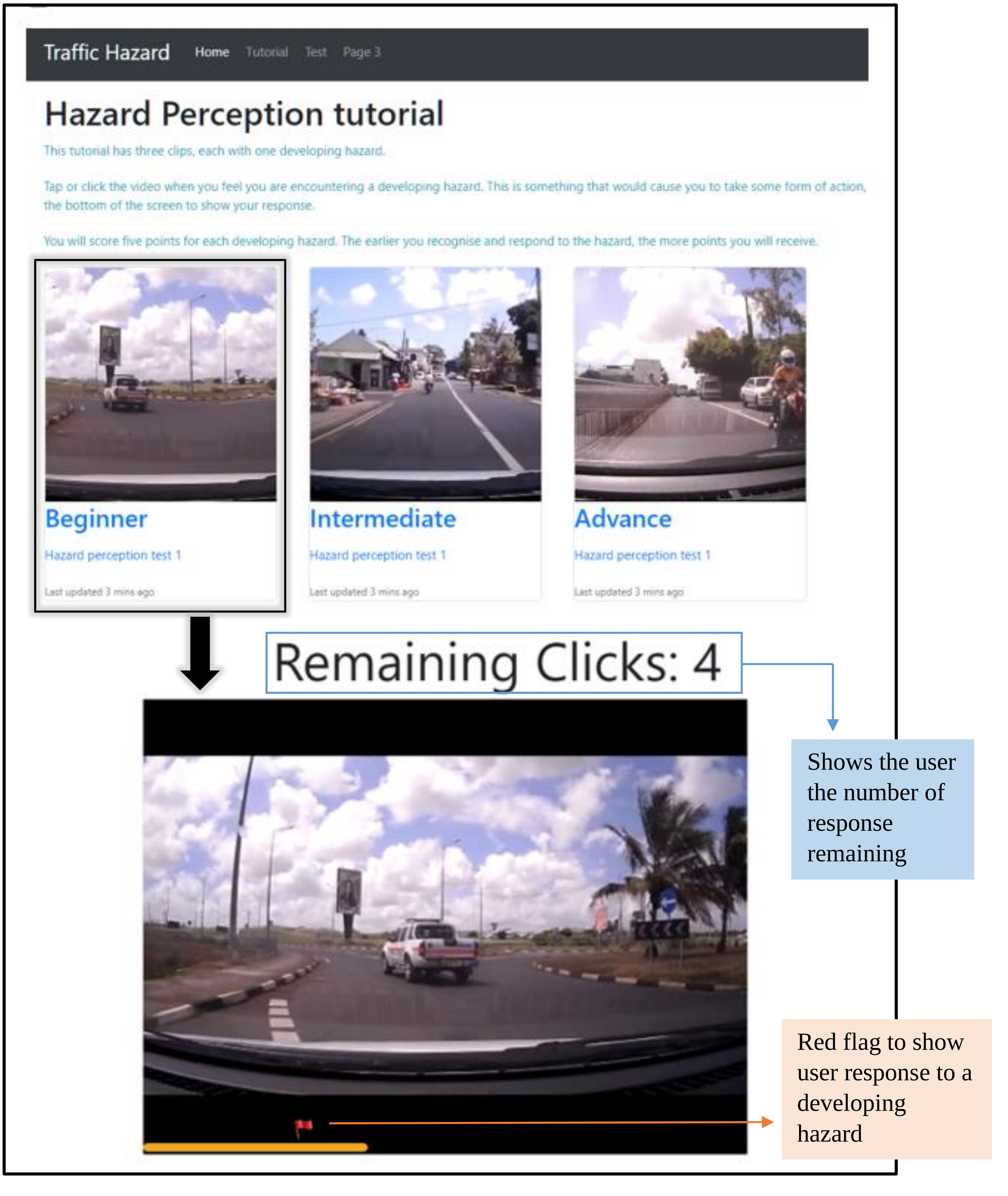


Figure 6.6: Tutorial screen layout

6.6.5 Test Screen

Figure 6.7 below displays the screen layout before and after agreeing to take the hazard perception tests. In particular, the test consists of a series of 20 videos having at least one developing hazard and to a maximum of 2 hazards in each clip.

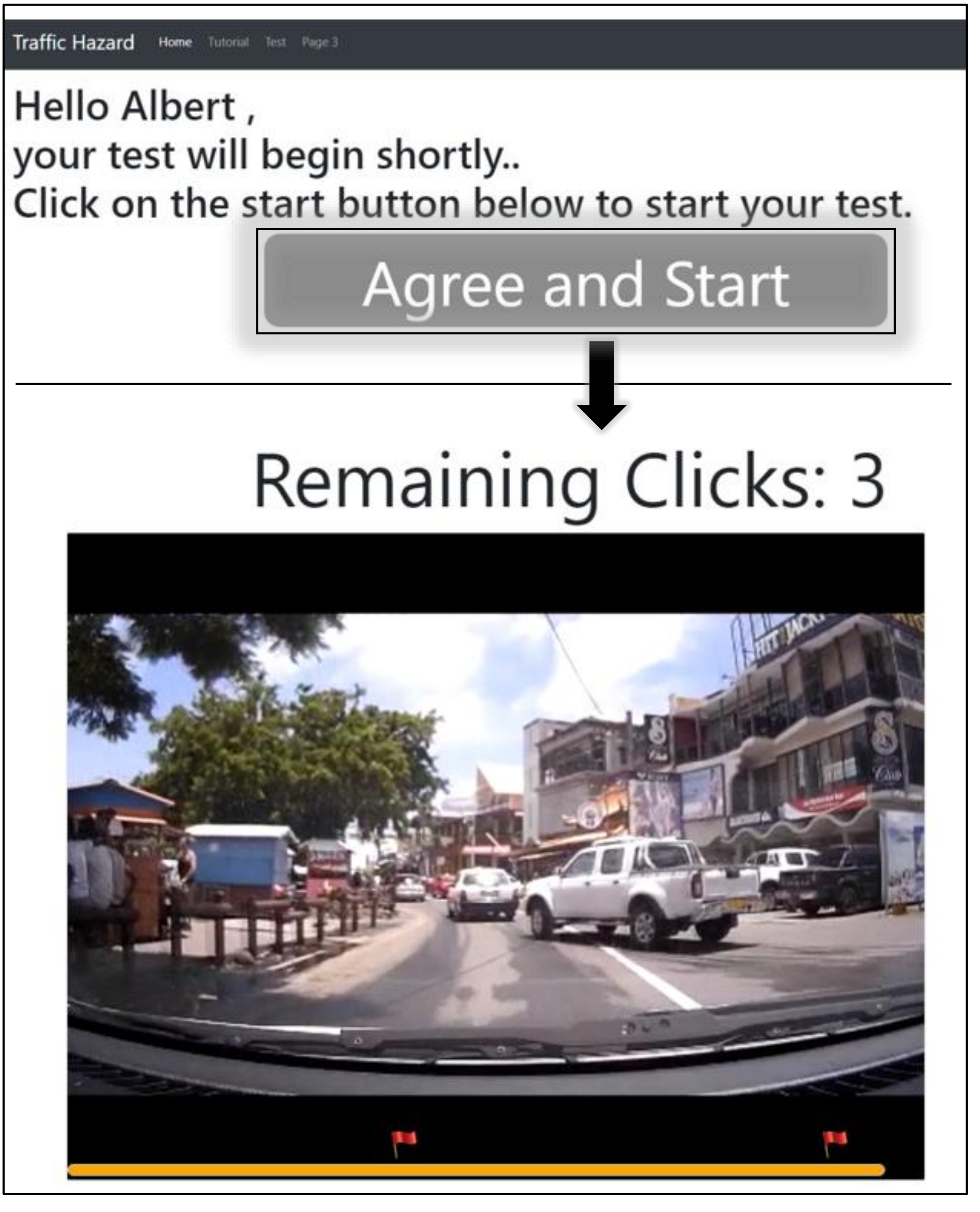


Figure 6.7: Test screen layout

6.7 Functional Testing

After the implementation of the proposed web application was completed, the website was duly tested in order to identify potential functional errors that could arise during its operation. Therefore, to identify those errors, the functional testing methodology also known as black-box testing was applied to test whether the web application satisfies all the predefined functional requirements which were presented in section 5.1.1. As such, the following table presents the results of the functional testing which was performed on the web-based application:

Requirement ID	Test	Expected Result	Actual Result	Test Status
FR01	Enter valid sign-up details in the registration form.	The user is added to the system with all the specified details.	The personal details of the user are added to the system.	Testing Passed
FR02	Enter valid input details in the login form.	The user is redirected to the test webpage.	The system allows access to the test webpage.	Testing Passed
FR03	Press on the “logout” button in the homepage.	The user is logged out and is redirected to the login interface.	The system redirects to the login interface.	Testing Passed
FR04	Enter invalid input details in the login form	An informative message will be displayed to the user if invalid credentials details are entered	The systems shows an error message on adding wrong input details in the login form	Testing Passed
FR05	Select another language from the home page	The user is able to view contents of the web application in the selected language	The website contents are displayed in a different language to the user	Testing Passed
FR06	Navigate on the website without taking tutorial and test	The user is not able to view any videos	The system does not allow users to view any videos prior to any particular test.	Testing Passed

FR07	click on 'tutorial' in the home page and then click on 'start' button	The user is able to view the video after clicking on the start button	The system allows video to play on clicking on the start button	Testing Passed
FR08	Without registering on the system, click on 'tutorial' in the home page	Any user is able to take a tutorial	The system allows unregistered users to take tutorial.	Testing Passed
FR09	Upon registering on the system, click on 'test' from the home page.	Registered users are able to take tutorial and test.	The system allows registered users to do both the tutorial and test.	Testing Passed
FR010	Click on 'start' button to initiate a video and then click on the video to response to a developing hazard	The user is able to view a response from the system once an action is performed to a developing hazard	The systems records the user's response to a developing hazard and a 'red flag' is shown to the user	Testing Passed

Table 6.1: Functional Testing Results

As shown in Table 6.1, each functional requirements had an expected result and actual result. The expected result is the result which the functional requirement should give whereas the actual result is the result after replicating the test on the web-based application. Each test conducted also consisted of a status tag that was either denoted as 'Testing Passed' or 'Testing Failed' after performing the respective tests. As such, after analyzing the testing results, it could be concluded that all of the functional tests were successfully tested and were tagged as testing passed, meaning that the web application have successfully met all of the functional requirements as pre-defined earlier in Chapter 5.

Chapter 7 Hazard Perception Test

Following the development of the web-based application for assessing the hazard perception skills of Mauritian drivers, the next sub-sections provide information about how the hazard perception test was designed and the method used for evaluating the hazard perception skills of drivers in Mauritius.

7.1 Methodology for hazard perception testing

Figure 7.1 below displays the various steps that were involved for designing and evaluating the hazard perception levels of Mauritians drivers.

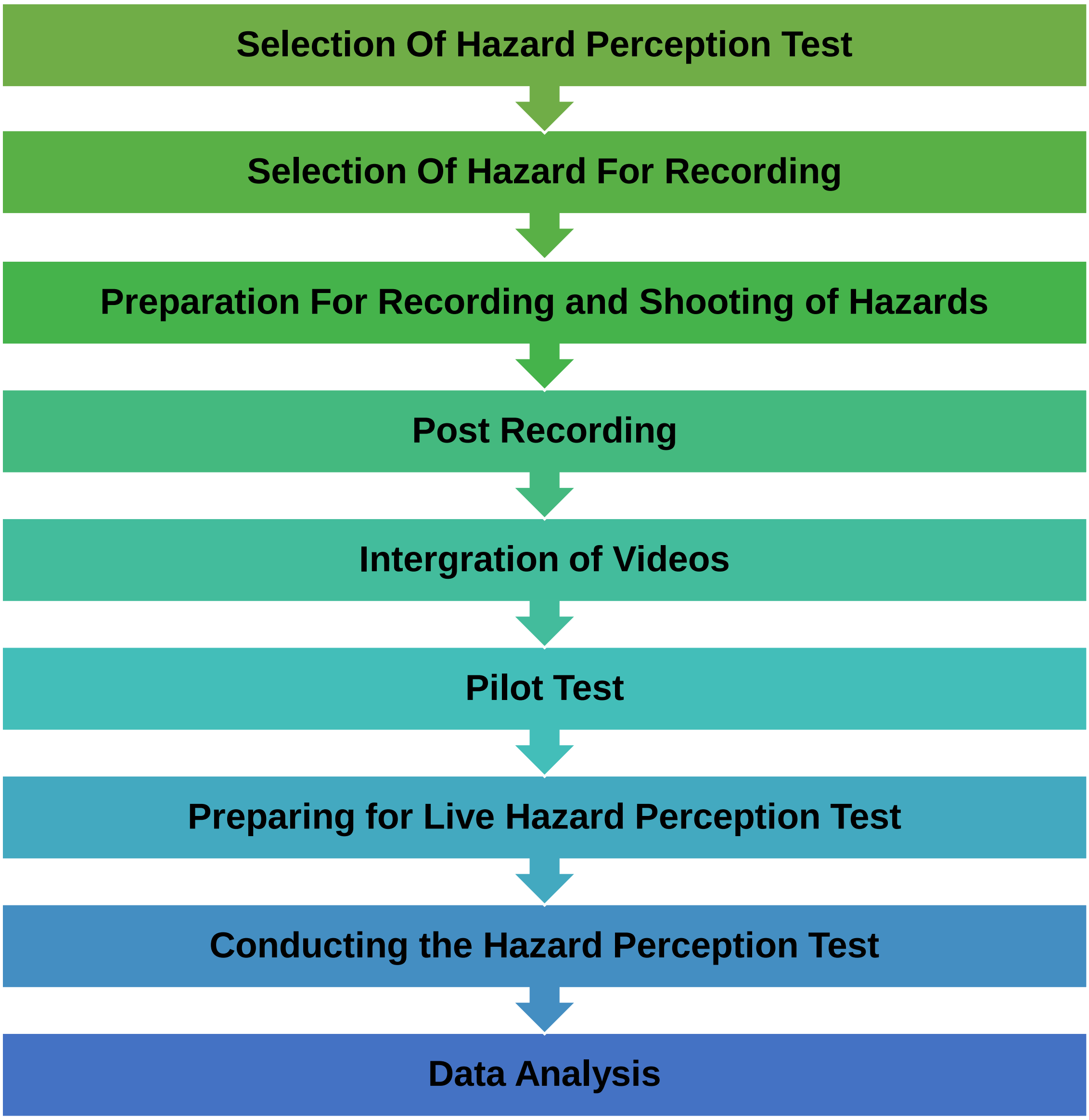


Figure 7.1: Methodology for hazard perception testing

7.1.1 Selection of Hazard Perception Test Approach

The test mode in this research study uses the dynamic hazard perception tests. Recent studies regarding hazard perception tests can be categorised into three main types, the first one being static hazard perception tests, the second one as driving simulators and the third being dynamic hazard perception tests (Chou & Chuang, 2014). Static hazard perception test consists of static pictures or textual test questions that are presented to candidates and are required to indicate the conflict points that may cause road accidents, or is likely to cause a road hazard. The second method uses a driving simulator to train and test drivers, and the simulator is designed so that environmental conditions and hazardous situations can be controlled and thus the candidates' driving behaviours during the test are observed. The third test mode, dynamic hazard perception tests uses visualization for a hazard perception test in which candidates watches video scenes that are have been made from real traffic footage and has the aim of identifying the hazardous conditions. Essentially, a number of traffic scenes are displayed on the screen in video mode by using customized software and when the candidate identifies a developing hazard, he or she must click the mouse immediately as a response to the hazard. As soon as the mouse is clicked, the software displays a response to make the person aware of the click, and the answer is stored in the system.

As mentioned earlier, this study uses the dynamic hazard perception tests in order to view video scene simulating a real driving context and to identify the change in road conditions so that the candidate taking the test simulates the driving context of operating a steering wheel. Essentially, 13 traffic context scenes are displayed on the screen in video mode, and the each video contains at least a developing hazard and requires some appropriate reactions or evasive actions such as braking, swerving to the right or left. Each time the candidate identifies a developing hazard he or she must click the mouse immediately and the system will display a red flag to make the person aware of the click as a confirmation and the response to the developing hazard is recorded.

7.1.2 Selection of Hazard for Recording

Based on the hazard taxonomy presented in chapter 2 as part of the literature review, the road hazards were recorded around the island. In particular for the road category, narrow lanes and road debris were selected since its occurrence is more significant within the Mauritian context. Similarly for the animal category, sudden crossing of animals was recorded whereas with regards to human related action road hazards such as cyclist emerging abruptly, dangerous overtaking and the risk of pedestrians to cross the road were recorded.

7.1.3 Preparation for Recording and Shooting of Hazards

The test videos that have been used throughout the hazard perception test have been recorded from the interior of a car so as to obtain traffic footage from the driver’s viewpoint and thus simulating the real view of a driver. In particular, a car dash-cam that can record video resolution up to 1080 pixels was mounted inside the car in front of the driver’s seat close to the driver’s sight line as shown in Figure 7.2 below. Additionally, this setup was also adopted so as the candidate taking the hazard perception test can be more familiar with the real driving context as well as has a proper real-time handling in the actual driving environment. After the setup was completed, the traffic scenes were recorded on different roads throughout the Island such as motorways, rural and urban arterial roads as well as near some coastal areas. Besides, some of the challengers that were encountered during the recording of the road hazards were mainly to stabilise the camera from time to time so as to have better video footage as well as to transfer videos after each session due to lack of internal storage space of the car dash-cam.

Figure 7.2: Setup for recording traffic scenes

7.1.4 Post Recording

The recorded videos were reviewed in order to identify segments containing the developing hazards and these videos were edited out as test items. Initially, 15 segments were prepared and then relevant experts from Mauritius Police Force and academics reviewed the videos in terms of “hazard perception relevance” and as applicable to Mauritian context. After the screening process was completed, 13 videos were selected as test questions for this research study. As such, the duration of each video was made to about 20 to 30 seconds together with a five-second countdown before the start. Out of the 13 videos, two of them consists of a maximum of two developing hazards and the remaining 11 videos have one main developing hazard. The time of occurrence of the developing hazard was calculated from the very start of the risk to the end of risk (risk interval) and it should be perceived as soon as it occurs in principle and as a delay in perception and response might result towards a vehicular collision. Therefore, as long as appropriate reactions in response to the developing hazard such as braking, slowing down and swerving to the right or left are made within the risk interval period unnecessary accidents can be avoided. In-particular, the developing hazards for the test questions include the risks such as pickup emerging at three-way intersection, car overtaking dangerously, sudden crossing of pedestrians, animals emerging and trying to cross the road, cyclists and vehicles emerging abruptly from a lane and among others. The main risk items and risk intervals of the different test questions are listed in Table 7.1 below.

Test Question Code	**Main Risk Item Description**	**Risk Interval (Sec)**	**Risk Duration (Sec)**
A100	Risk of dog emerging and trying to cross the road	14.00 ~ 17.00	3.00
H100	Risk of pickup to overtake dangerously	12.00 ~ 14.00	2.00
H1001	Risk of man jumping out of lorry on main road	16.00 ~ 19.00	3.00
H1002	Risk of pedestrians to cross the road	8.13 ~ 11.13	3.00
H1003a	Risk of pedestrians with carriage stroller crossing the road	11.25 ~ 14.25	3.00
H1003b	Risk of pickup emerging at three-way intersection	24.07 ~ 28.07	4.00
H1004	Risk of roadside pedestrian to cross	12.00 ~ 14.00	2.00
H1005	Risk of car overtaking dangerously	17.00 ~ 19.00	2.00
H1006	Risk of pedestrian crossing while talking on mobile phone	8.21 ~ 10.21	2.00
H1007a	Risk of students to cross the road at three-way intersection	20.00 ~ 24.00	4.00
H1007b	Risk of pickup turning right at three-way intersection	44.00 ~ 48.00	4.00
H1008	Risk of road worker to cross the road	14.00 ~ 17.00	3.00
H1009	Risk of cyclist emerging suddenly from branch into main road	6.00 ~ 9.00	3.00
H10010	Risk of car reversing on main	17.00 ~ 20.00	3.00

H10011	Risk of car changing lane suddenly on motorway	10.00 ~ 15.00	5.00

Table 7.1: Main risk items and risk intervals

In terms of the question content, the risk of a pickup emerging at three-way intersection in Test Question 'H1003b' is taken as an example and is described below in Figure 7.3. Near the three-way intersection, a pickup appears and suddenly emerges to right without any deceleration. At this point, the driver from the opposite side should apply the brake pedal to slow down so as to avoid crashing into the pickup. From this perspective, the candidate taking the hazard perception test scores 5 marks as he or she will take an immediate action on seeing the pickup emerging to right at the three-way intersection. On the other hand, if the candidate takes more time to react in response to the developing hazard as shown in the schematic diagram below, the marks decreases accordingly.

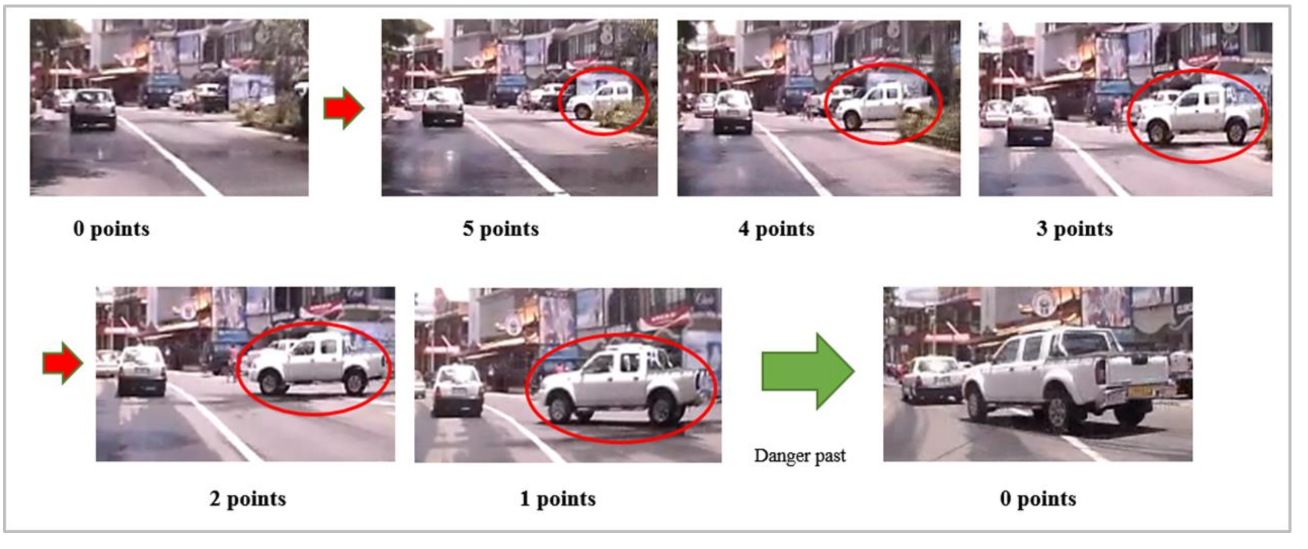


Figure 7.3: Scoring Intervals

7.1.5 Integration of Videos

After all the selected videos for the hazard perception test were edited and finalized, the videos were eventually integrated in the web-application database. As such, each of the videos within the database was assigned a unique video identification number, a short description of the hazard, the risk interval and the hazard duration so as to make the data analysis easier.

7.1.6 Pilot Test

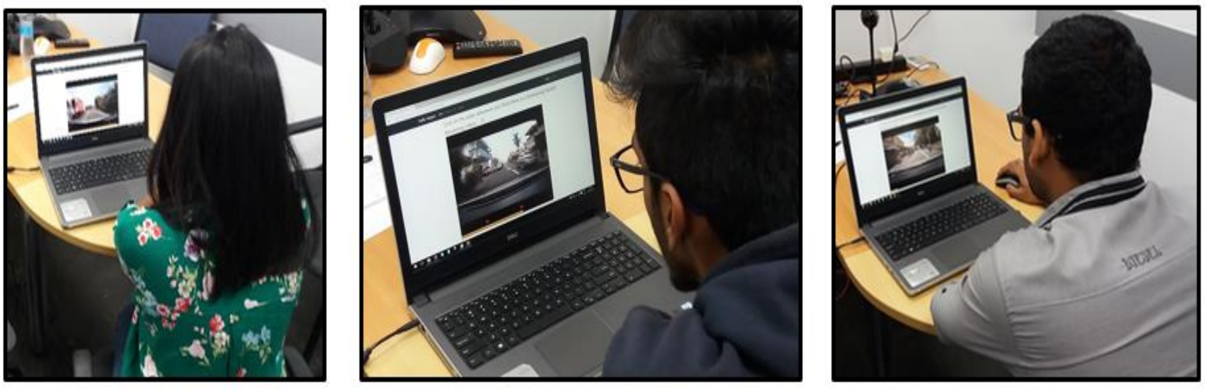
Before assessing the hazard perception level of Mauritian drivers, a pilot study was conducted so as to have some feedback on the web-application which was developed. As such, 10 participants comprising of 5 riders from the Mauritius Police Force and 5 driving school instructors were recruited to take part in the pilot phase. Particularly, the feedback which was gathered from the pilot study were related to the time of occurrence of the developing hazard and most of the participants agreed that the time of occurrence and risk interval used for each developing hazard as described earlier in Table 7.1 are appropriate as well as the traffic footage used are within the Mauritian context.

7.1.7 Preparing for Live Hazard Perception Test

Around 270 users were targeted to take part in the hazard perception test and a formal request seeking for assistance to conduct the hazard perception test was made to the licensing inspector at Police Headquarters Line Barracks as well as to University of Mauritius and Spoon Consulting. The sampling size was determine by using the population size as 933,160 from Statics Mauritius (2018), where it was assumed that individual having above 20 years old have a competent driving license. This method was adopted since data about the exact number of people having a valid driving license was not available. As such, after specifying the population size, confidence level as 90% and a margin error of 5% the ideal sample size was found to be 271 participants.

7.1.8 Conducting the Hazard Perception Test

To assess the hazard perception levels of Mauritian drivers, three categories of road users have been targeted where it includes learners, novices drivers with less than six months of experience and experienced drivers with more than three years of driving experience. Generally, most of the learners and some experienced drivers who participated in the study were recruited with the help of Police officers from Headquarters Line Barracks and these participants were going for their practical driving test. In addition, different Police officers from various departments such as Road Safety Unit, Traffic Enforcement Services, Licensing Office and Special Support Unit personnel's took the hazard perception test. Moreover, academics and staff members from Middlesex University, University of Mauritius and Spoon Consulting also participated in the research study. To begin with, each participant taking the hazard perception test was informed about the purpose of this research study and they were required to fill-in a registration form with their name, address, email, gender and driving competency. After completing the registration process, each research participant was guide through a series of tutorials along with some explanations before taking the hazard perception test. Figure 7.4 below shows the three categories of road users taking the hazard perception test.



Learner Novice driver Experienced driver

Figure 7.4: Participants taking the hazard perception test

Chapter 8 Results and Discussions

8.1 Demographic Details of Participants

8.1.1 Gender Distribution

Out of the 273 participants who took part in the hazard perception test, 76.1% of them were male and the other 23.9% were female as shown in Figure 8.1. As such, a slightly higher percentage of participants of this study were male.

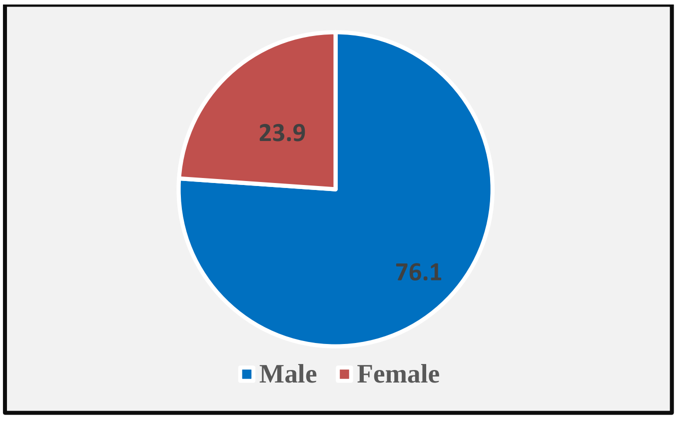


Figure 8.1: Gender distribution of Participants

8.1.2 Age Group Distribution

Figure 8.2 displays the age group distribution of the participants who took part in the hazard perception test. From the findings, it could be found that more than half of the total number of participants were aged between 21 and 30, whereas the smallest percentage (2.0%) of participants were above the aged of 61.

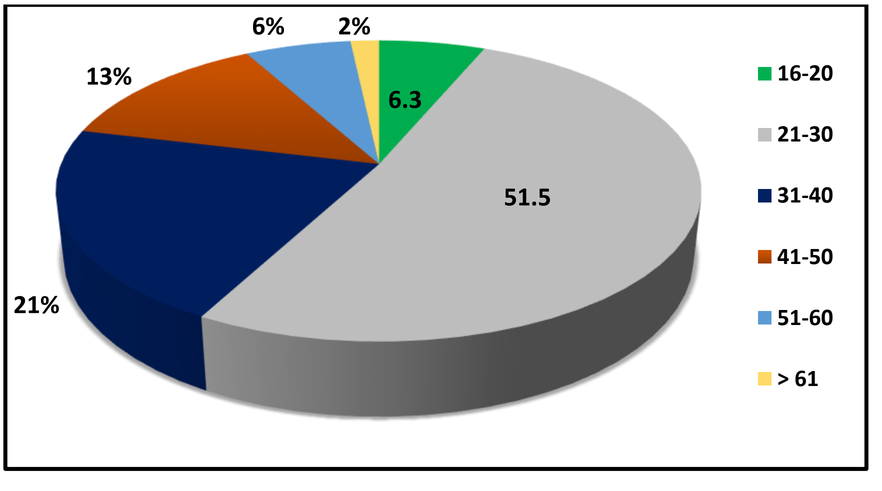


Figure 8.2: Age group distribution

8.1.3 Driving Competency

From the results obtained, it could be observed that the participants who took part in the hazard perception test, a majority of them, 76.1%, were competent drivers who possessed a valid driving license as compared to 23.9% who were learners and had a temporary driving license.

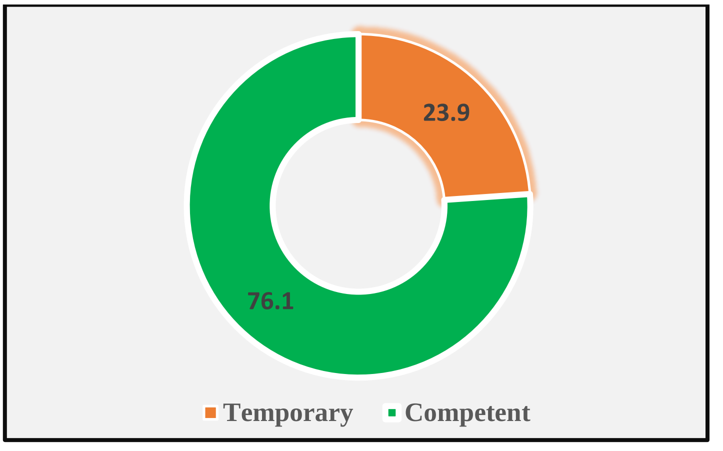


Figure 8.3: Type of driving competency

8.1.4 Driving Experience

Figure 8.4 shows the driving experience of the participants who took part in the research study. As such, most of the participants, 35.7%, have a driving experience of more than 10 years as opposed to 1.8% who have less than 6 months of driving experience. This difference in the result is mainly due to the fact that most of the research participants who have more years driving experience were competent drivers whereas the participants with lesser driving experience were mainly learners.

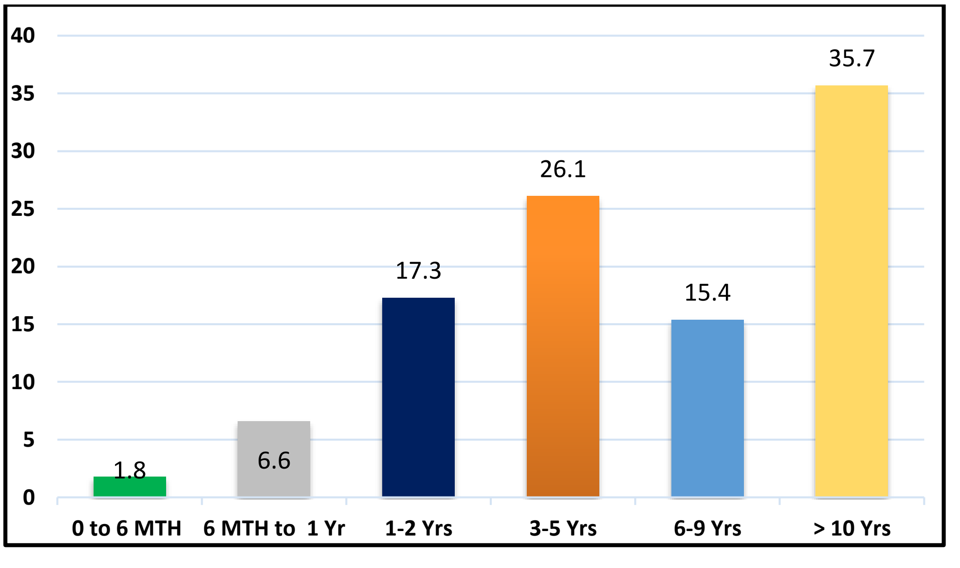


Figure 8.4: Driving experience

8.1.5 Type of vehicle

The type(s) of vehicle that was used by the participants is displayed in Figure 8.5. From the findings, it can be concluded that a majority number of the participants, 97.8%, who took the hazard perception test used private car on a regular basis followed by motorcycle, which was about 26.5%, and among others.

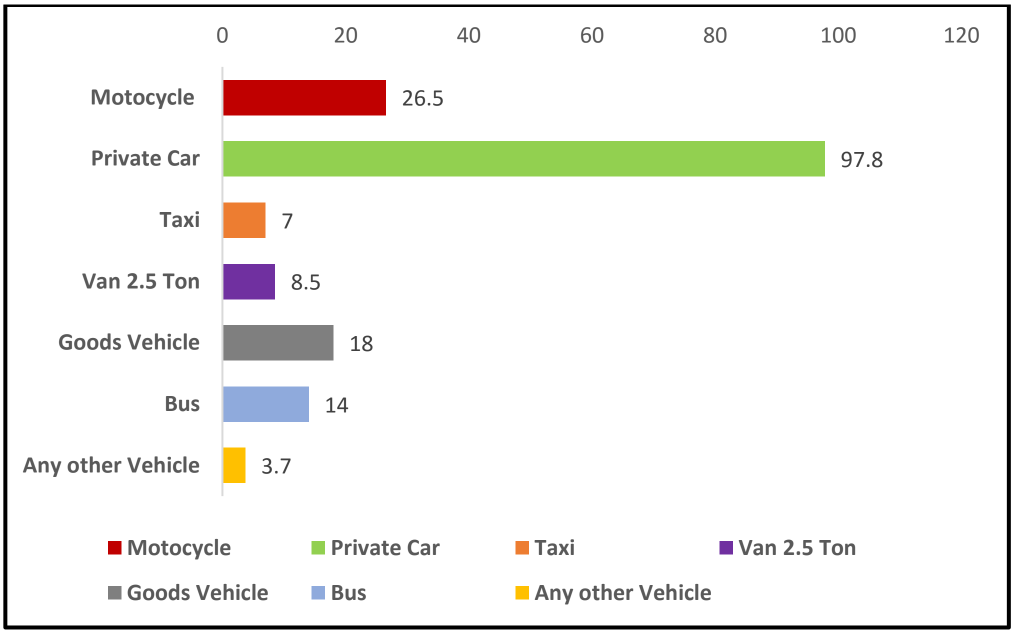


Figure 8.5: Types of vehicle used frequently

8.2 The Influence of Demographics on Hazard Perception Skills of Drivers

Using the methodology defined in the previous section, data was collected and analyzed to investigate the influence of the research participant's demographic on the hazard perception skills of drivers. As such, the following sub-sections presents the key findings of the research study.

8.2.1 Gender and Hazard Perception Skills

The relationships between gender and the overall test score of the research participants were studied and the findings are given in the box-plot in Figure 8.6 below. From the chart, it could be observed that the median test score of the male participants was 27 marks and it was found to be slightly lower than that of female participants, which was 30 marks. This result shows that women expressed higher levels of concern regarding potential road hazards within the driving environment than men. Some previous studies have reported gender differences in hazard perception where the risk is much higher for males than females while others have reported no such effects (Scialfa, et al., 2010).

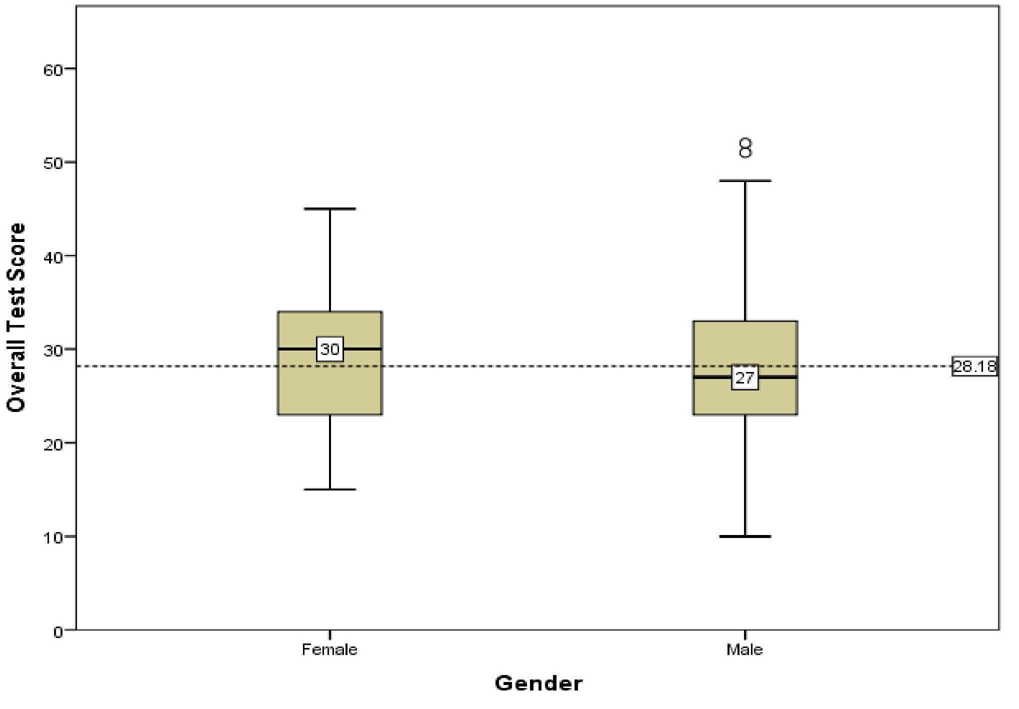


Figure 8.6: Gender and overall test score relationships among research participants

8.2.2 Age Group and Hazard Perception Skills

The results of the test score against the age group distribution of the research participants for the hazard perception test is given in Figure 8.7 below. From the box-plot chart, it could be found that participants who were aged between 60 to 70 years old have a poor hazard perception level as compared to participants who are less than 40 years old. These findings aligns with a previous study which assessed the hazard perception skills of older drivers aged above 65 years old and the results were insightful showing that the hazard perception ability declines with increasing age mainly due to poor cognitive ability such as useful field of view and other vision related factors (Horswill, et al., 2008). In-line with this perspective, other studies such as Underwood, et al., 2005; Olson & Sivak, 1986, highlights that hazard perception level decreases with age.

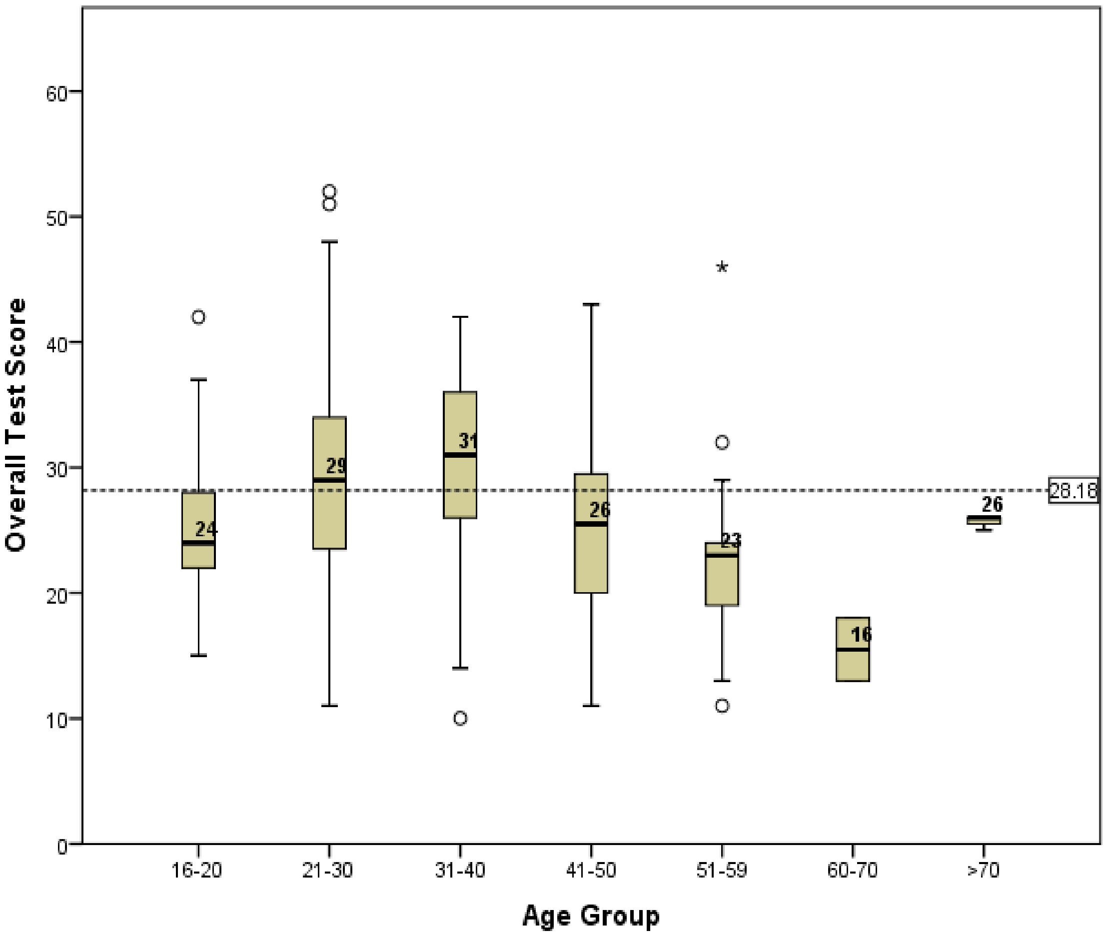


Figure 8.7: **Age group and overall test score relationships among research participants**

8.2.3 Driving Competency and Hazard Perception Skills

The relationships between driving competency and the overall test score of the research participants are given in the box-plot diagram in Figure 8.8. As such, it could be seen that the median test score of temporary drivers was 26 marks and was found to be slightly lower than that of competent drivers which was 29 marks. The finding is in line with the results of a previous study confirming that hazard perception among temporary drivers are lower due to inexperience, inefficient scanning of driving environment and poorer recognition of road hazard due to a low number of past exposures (Tuske, et al., 2018).

>70

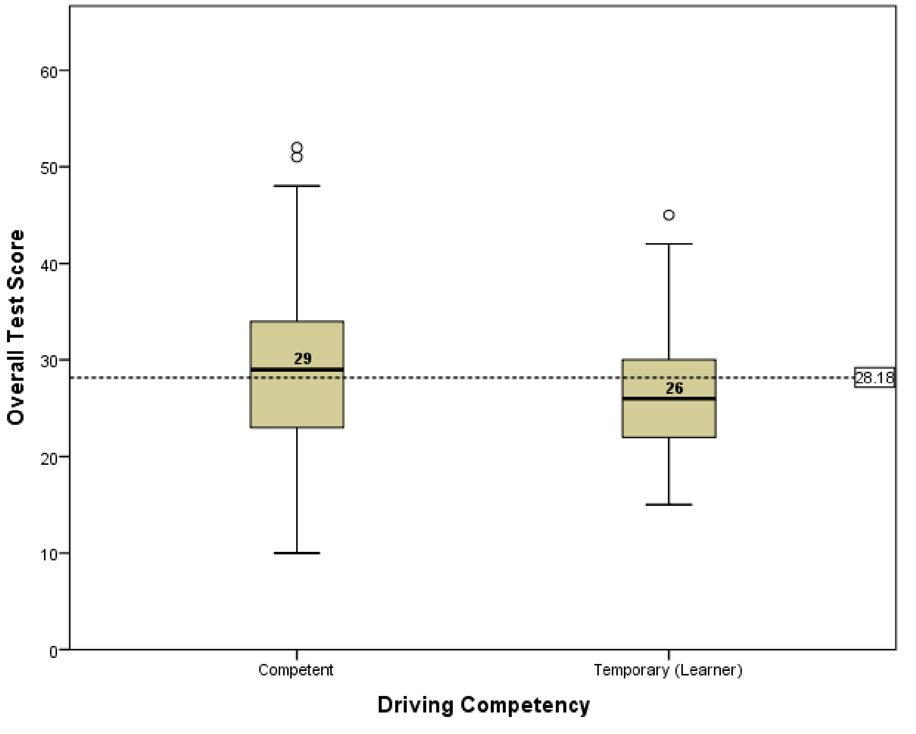


Figure 8.8: Driving competency and overall test score relationships among research participants

8.2.4 Driving Experience and Hazard Perception Skills

The box-plot in Figure 8.9 displays the result for the relationship between the driving experience of the participants against the overall test score for the hazard perception test conducted. From the outcome, it could be found that the research participants who had a driving experience of 6 months have a low hazard perception level as opposed to the participants having a driving experience between 5 to 10 years. This result is similar as compared to some previous studies conducted by Scialfa, et al., 2010 and Crundall, 2015 where it was found that novice drivers have a very poor hazard perception level due to inexperience and impoverished mental models whereas experienced drivers are better able to perceive and identify road hazards within the required time period, thereby reducing collision risks.

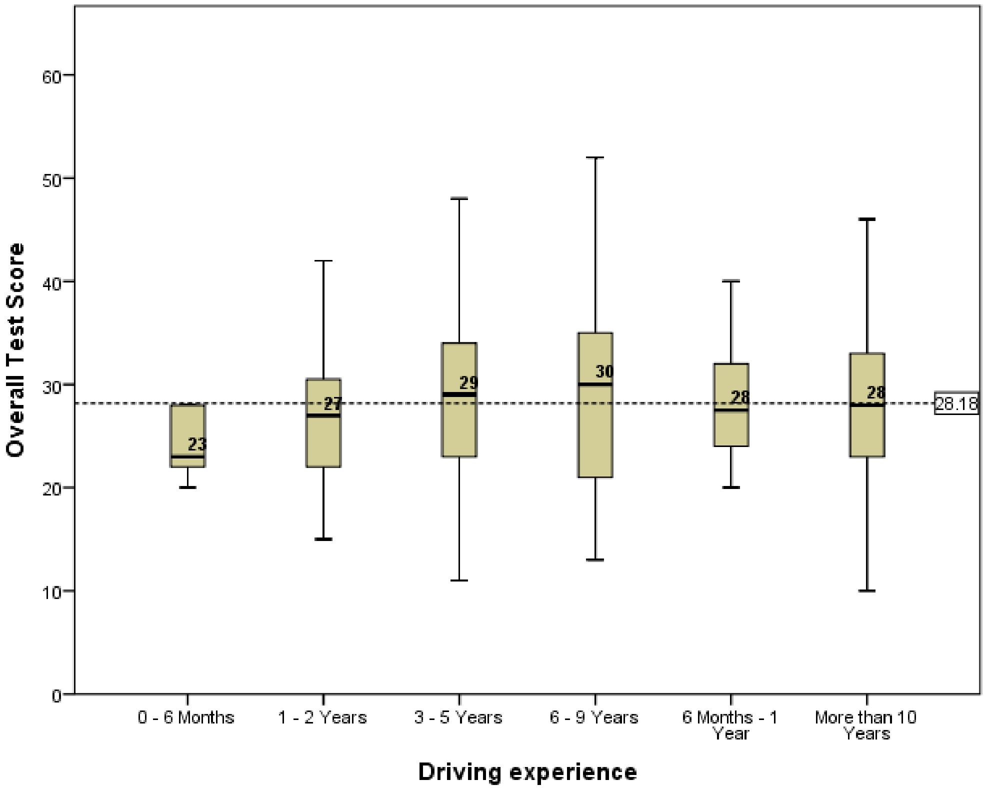


Figure 8.9: Driving experience and overall test score relationships among research participants

8.1.5 Type of Vehicle Driven and Hazard Perception Skills

Figure 8.10 shows the relationships between the type of vehicle and overall test score among the research participants. From the bar chart below, it could be found that participants who were utilizing multiple vehicles such as private car, good vehicles, bus and van on a regular basis had a higher hazard perception level opposing to participants using only one type of vehicle such motorcycle, which was 36 marks as compared to 18 marks respectively. In line with the results and within the Mauritian context it could found that the number of fatalities involving motorcycles were 38.2% as compared to 16.0% for road users such as buses, vans and lorries throughout the year 2018 (Statistics Mauritius, 2018). Therefore, these findings indicate that motorcycles users with a low hazard perception level are more prominent to be involved a vehicular collision.

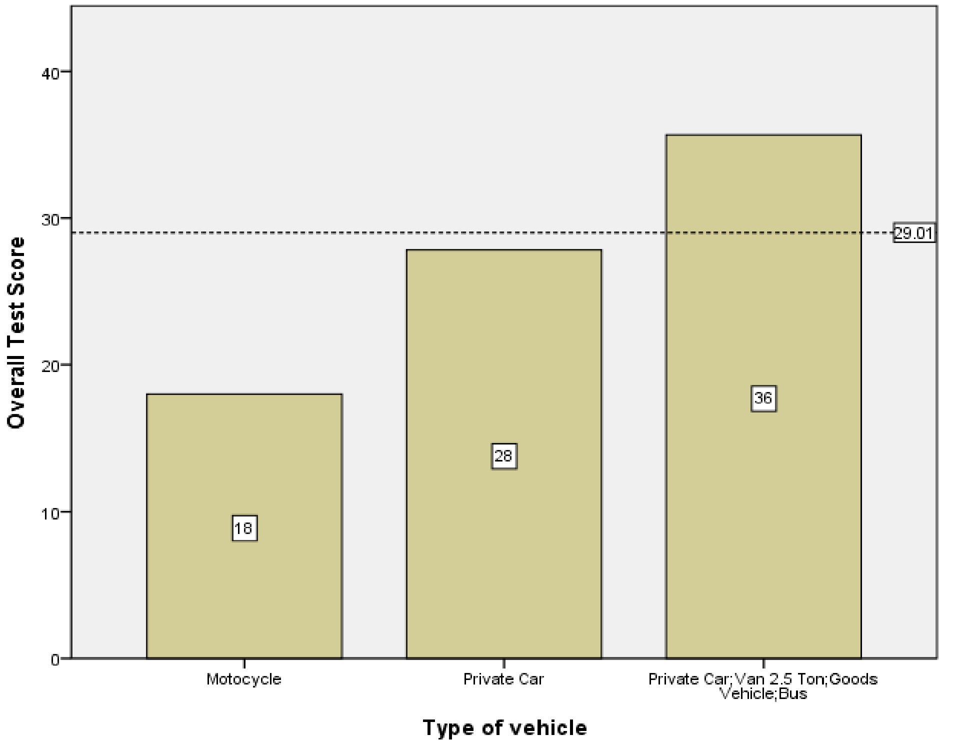


Figure 8.10 Type of vehicle and overall test score relationships among research participants

8.3 The Influence of Hazard Category on Hazard Perception Skills of Drivers

The relationships between the hazard category and the overall average test score of the research participants who took part in the hazard perception test were studied and the findings are given in the chart below in Figure 8.11. From the results, it could be found that the road hazard which was poorly perceived in the test was the 'risk of a road worker to cross the road' where the overall average score was found to be 0.6 over a scale of 5 points. Moreover, the 'risk of a car changing lane suddenly on a motorway' was also identified to be poorly perceived by the participants where the overall average score was found to be 1.0 points. These results points out to the fact that most of the research participants were not able to respond to developing hazards within the required risk interval period so as to take appropriate actions in order to avoid unnecessary vehicular collisions. On the other hand, the road hazards which were appropriately perceived in the test were the 'risk of pedestrian to cross the road' and 'risk of a dog emerging and trying to cross the road' where the overall average score was found to be 3.3 and 2.9 points respectively. More details about the results of the individual hazard categories can be found in Appendix A.

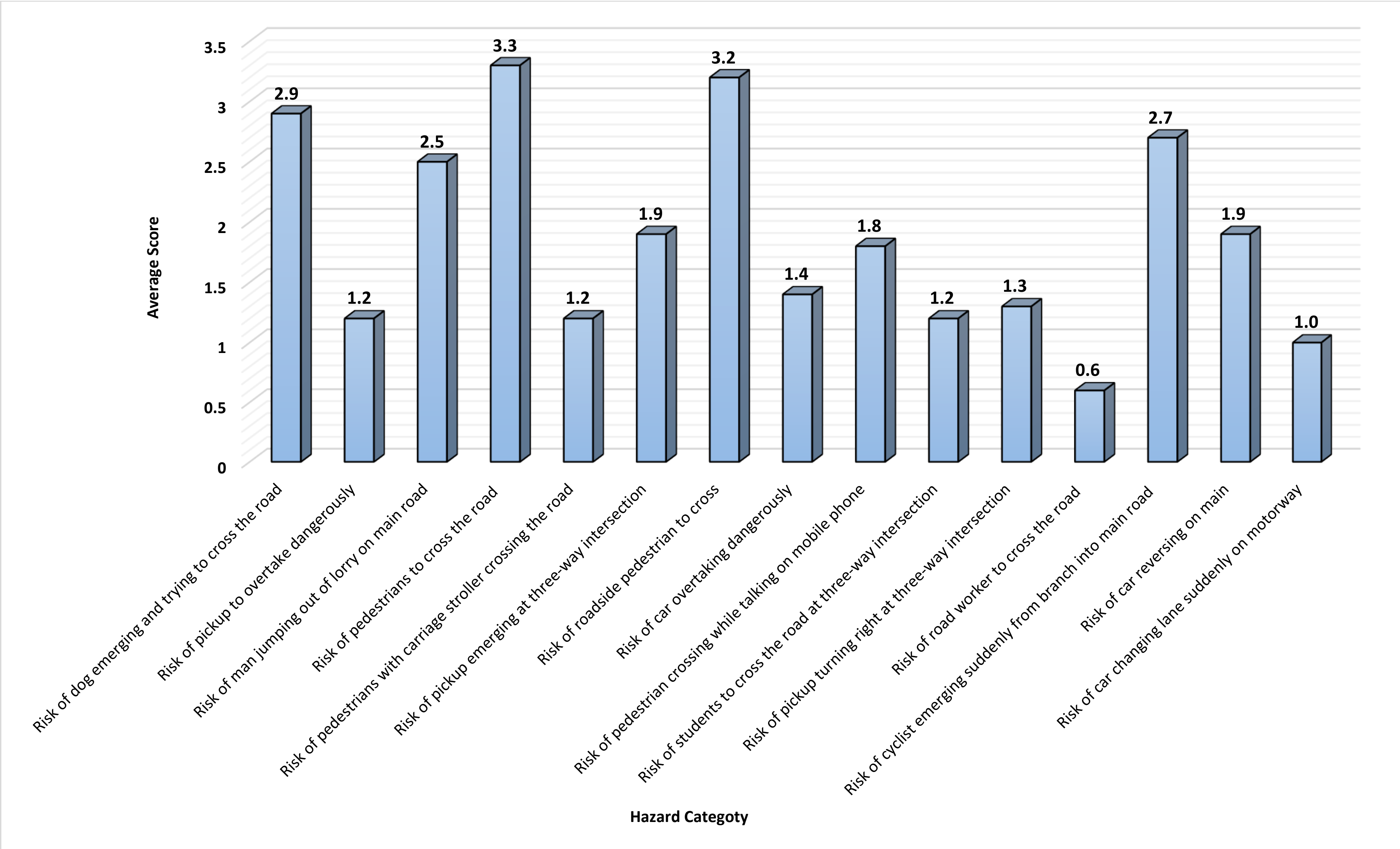


Figure 8.11: The influence of hazard category on hazard perception skills of drivers

8.4 General Discussions

From the findings, it could be found that the overall average hazard perception score of the participants who took part in the test was 28.1 points. This score indicates a poor performance with regards to the hazard perception level of the drivers who participated in the research study. The reasons that led to the low performance during the hazard perception test can be attributed to various factors. As such, it was found that learners and novice drivers had a very poor hazard perception level due to inexperience, impoverished mental model, inefficient scanning of driving environment and a poorer recognition of road hazards. Furthermore, it could also be found that the hazard perception skills of drivers declines with increasing age (above 65 years old) mainly due to poor cognitive ability and vision related factors.

8.5 Recommendations

Figure 8.12 below displays the proposed roadmap for the implementation of the Hazard Perception Test Tool as part of the current driving license test in Mauritius. To begin with, in Phase 1, there will be a stakeholder analysis with regards to the inclusion of the new Hazard Perception Test in the current driving licensing process and the feedback obtained would be used to further improve the proposed tool thereby leading to the dissemination through concerned authorities and news media. Furthermore, in Phase 2 it will involve the amendment through legislative requirements to the learner's license process by including training and the necessary tools to assess a driver's hazard perception level. After successfully passing the required criteria for both the audio-visual test (Oral Test) and the Hazard Perception Test, the candidate will then proceed to the practical on-road driving test in Phase 3 in an attempt to obtain a competent driving license. There also needs to be sensitization campaigns to educate people about the importance of hazard perception training and should be offered as well as availability of such kind of tools to facilitate this process.

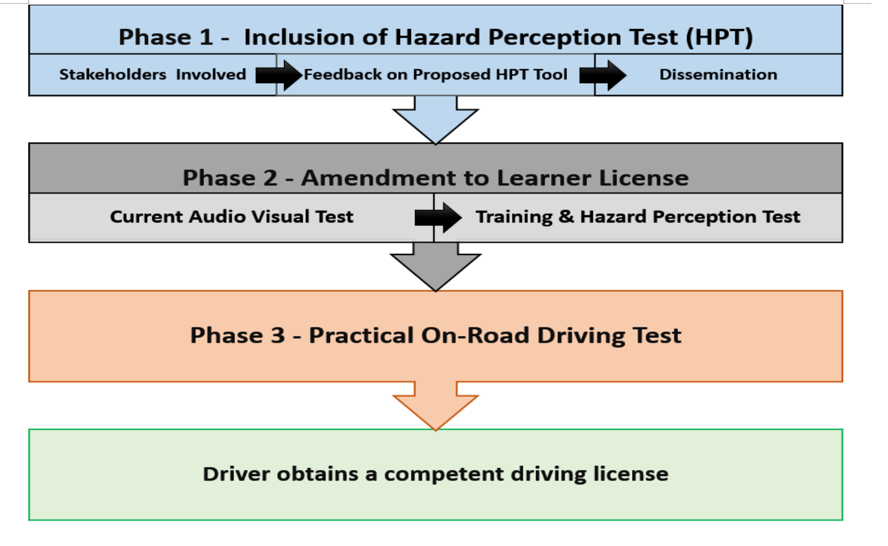


Figure 8.12: Roadmap for the implementation of proposed Hazard Perception Test

Chapter 9 Conclusion and Future work

9.1 Conclusion

Although drivers have to go through training and testing phases before earning a competent driving license in Mauritius, the number of road accidents has been continuously increasing over the past few years within the island. Therefore to address this growing concern of road accidents in Mauritius, several measures have been put in place by different stakeholders. For example, to control speeding on the road, various speed cameras have been deployed at different locations throughout the island. In addition, different mobile speed traps are also being randomly carried out every day around Mauritius in an attempt to further detect drivers exceeding the speed limit in regions where fixed speed cameras are not available. With regards to controlling drunken drivers, several mobile patrolling teams are regularly deployed to various regions within the island to perform Alco-test exercises in suspected cases. Even though the above-mentioned measures have been taken to address key issues like driving under influence of alcohol, speeding, low road safety awareness and among others, limited work has been done in the area of road hazards and hazard perception level of Mauritanian drivers. As such, this research study aims to develop an interactive web based multimedia tool named "MauHazard" to assess the hazard perception skills of drivers specific to the Mauritius context.

To begin with, a literature review was conducted in the view of investigating the key parameters involved for the development of the hazard perception tool. In particular, in this phase, there has been the identification of key road traffic hazards within the context of Mauritius and a hazard taxonomy was formed. In addition, there has been the recording of real road traffic footage based on the identified hazards from the literature review conducted. Eventually, after the compilation of traffic hazards specific to the Mauritian context, the interactive web-based hazard perception tool was developed and tested against its pre-defined list of functional requirements.

Following the development of the tool, it involved the assessment of the hazard perception level of Mauritian drivers which encompassed three categories of road users amounting to a total of 273 participants. It included learners, novice drivers with less than six months of experience and experienced drivers with more than three years of driving experience. Most of the learners who took part in the study were recruited with the help of Police officers from Headquarters Line Barracks. With regards to the remaining two categories, academics and staff members from Middlesex University, University of Mauritius and Spoon Consulting participated in the research study. Ultimately, after assessing the hazards perception level of the drivers which lasted for about four months, the data collected were entered in SPSS for further statistical analysis.

From the findings, it can could be found that the overall average score of the participants who took part in the hazard perception test was 28.1 points. This score indicates a poor performance and is related to various factors such as the participants who were aged between 60 to 70 years old had a poorer hazard perception level with an average overall score of 16.0 points as compared to participants who were less than 40 years old with an average overall score of 28.1 points. As such, it could be concluded that the hazard perception ability declines with increasing age mainly due to poor cognitive ability like useful driving field of view and other vision related factors. Moreover, it could also be found that the research participants who had a driving experience of 6 months equally had a lower hazard perception level with an overall average score of 26.0 points as opposed to participants with a driving experience between 5 to 10 years old. These results are in line with some previous studies where it was found that novice drivers have a very poor hazard perception level due to inexperience and impoverished mental models whereas experienced drivers are better able to perceive and identify road hazards, thereby reducing vehicular collision risks. Nevertheless, the fact that hazard perception is the only component of skill which is related to driving that has been found to correlate with vehicular accidents. Therefore, it is of utmost importance to provide appropriate training that will in turn improve the hazard perception skills of Mauritian drivers and therefore will positively contribute towards reducing accident liabilities around the island.

9.2 Future Works

Owing to the complexity of real road situations, hazard perception test contexts should be conformed to hazardous conditions in real driving processes. Thus, it is imperative for the test videos content to include hazard events in front of the vehicle, the sudden occurrence of hazard joining the car's path, situations regarding to oncoming traffic as well as they should be classified according to traffic environments such as weather conditions, road type and time interval. Therefore, in line with this perspective, in future studies an advance car-dash camera capable of recording in 4K (ultra-high dentition) will be used as well as hazardous context data will be collected and analyzed on a large scale so as to construct more systematic hazard perception training materials. In addition, for future studies the number of hazards can be extended in the hazard perception tool so as to better suit the hazard taxonomy presented as well as to promote the tool in the aim of increasing awareness with regards to the importance of hazard perception skills and in reducing road accidents.

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Appendices

Appendix A

Analysis of Individual Hazards Categories

The following sub-sections provide the results that were obtained while conducting the hazard perception test. In particular, the analysis entails various cross-tabulations and blot-pox charts of the score obtained for each hazard against the participant's gender, age group and driving experience.

Risk of dog emerging and trying to cross the road

Table 8.1 below shows the results that was obtained for the developing hazard, A100 where there was the risk of a dog emerging and trying to cross the road. From the findings, it could be found that a majority of the participants who scored five marks, 72.5% were male and 27.5% were females. On the other hand, 66 participants out of 272 were awarded no marks since they were not able to identify the developing hazard with the appropriate time frame.

		Risk of dog emerging and trying to cross the road						Total
		0	**1**	**2**	**3**	**4**	**5**	
Gender	**Female**	13	4	4	9	13	22	65
	Male	53	12	11	23	50	58	207
Total		66	16	15	32	63	80	272

Table 8.1: Cross tabulation for the risk of a dog emerging and trying to cross the road against participant's gender

Table 8.2 below shows the cross tabulation for the risk of a dog emerging and trying to cross the road against the participant's age group. From the findings, it could be found that most of the participants, 51.5% who scored the highest mark were aged between 21-30 years old as compared to the participants who were aged above 60 years old. However, on the other hand, 8.4% of the participants who were awarded no marks were aged between 31-80 years old, As such, this shows that drivers who are younger are better at perceiving a developing hazard more quickly as opposed to older aged drivers.

		Risk of dog emerging and trying to cross the road						Total
		0	**1**	**2**	**3**	**4**	**5**	
Age Group	**16-20**	5	2	0	0	5	5	17
	21-30	38	4	8	12	29	49	140
	31-40	8	5	3	9	16	16	57
	41-50	8	4	2	5	10	7	36

	51-59	6	0	2	5	1	3	17
	60-69	0	1	0	1	0	0	2
	71-80	1	0	0	0	2	0	3
Total		66	16	15	32	63	80	272

Table 8.2: Cross tabulation for the risk of a dog emerging and trying to cross the road against participant's age group

Risk of pickup to overtake dangerously

Table 8.3 below shows the results that was obtained for the developing hazard, H100 where there was the risk of a pickup to overtake dangerously. From the results, it could be observed that a majority of the participants, 33.0% were awarded no marks where 81.1% were males and 21.5% were females. On the contrary, only one female participant was awarded five marks since the developing hazard was identified within the given time frame.

		Risk of pickup to overtake dangerously						Total
		0	**1**	**2**	**3**	**4**	**5**	
Gender	**Female**	20	16	23	4	1	1	65
	Male	73	53	58	20	3	0	207
Total		93	69	81	24	4	1	272

Table 8.3: Cross tabulation for the risk of a pickup to overtake dangerously against participant's gender

Table 8.4 below shows the cross tabulation for risk of a pickup to overtake dangerously against the participant's age group. From the findings, it could be found that most of the participants, 34.1% scored zero mark where 2.2% were aged between 16-20 years, 11.7 % were aged between 21-30 years and the remaining 20.2% were aged above 31 years old. Only one of the research participant who was between the age group of 31-40 years old scored five marks.

		Risk of pickup to overtake dangerously						Total
		0	**1**	**2**	**3**	**4**	**5**	
Age Group	**16-20**	6	2	7	2	0	0	17
	21-30	32	35	53	16	4	0	140
	31-40	18	19	13	6	0	1	57
	41-50	21	10	5	0	0	0	36
	51-59	13	2	2	0	0	0	17
	60-69	1	0	1	0	0	0	2
	71-80	2	1	0	0	0	0	3

Total	93	69	81	24	4	1	272

Table 8.4: Cross tabulation for the risk of a pickup to overtake dangerously against participant's age group

Table 8.5 displays the cross tabulation for the risk of a pickup to overtake dangerously against the participant's driving experience. It could be found that a majority of the participants, 78.5% who were awarded no marks have a driving experience of more than 3 years old where 28.8% have a driving experience between 3 to 5 years, 19.2% having a driving experience between 6 to 9 years and 52.1% have a driving experience of more than 10 years. On the other hand, one of the participants who was awarded the highest score had a driving experience of more than 6 years.

		Risk of pickup to overtake dangerously						Total
		0	**1**	**2**	**3**	**4**	**5**	
Driving experience	**0 - 6 Months**	4	1	0	0	0	0	5
	6 Months - 1 Year	5	3	8	1	1	0	18
	1 - 2 Years	11	9	14	4	1	0	39
	3 - 5 Years	21	20	22	8	0	0	71
	6 - 9 Years	14	9	14	3	1	1	42
	More than 10 Years	38	27	23	8	1	0	97
Total		93	69	81	24	4	1	272

Table 8.5: Cross tabulation for the risk of a pickup to overtake dangerously against participant's driving experience

Risk of man jumping out of lorry on the main road

Table 8.6 below displays the results that was obtained for the developing hazard, H1001 where there was the risk of a man to jump out of a lorry on the main road. From the findings, it could be observed that a majority of the participants who scored five marks, 69.4% were male and 30.5% were females. On the other hand, 80 participants out of 272 were awarded no marks since they were not able to identify the risk of a man to jump suddenly out of lorry on the main road leading to a developing hazard.

		Risk of man jumping out of lorry on the main road						Total
		0	**1**	**2**	**3**	**4**	**5**	
Gender	**Female**	20	1	11	10	12	11	65
	Male	60	6	15	46	55	25	207
Total		80	7	26	56	67	36	272

Table 8.6: Cross tabulation for the risk of a man jumping out of lorry on the main road against participant's gender

Table 8.7 below shows the cross tabulation for the risk of a man to jump out of a lorry on the main road against the participant's age group. From the results, it could be found that 47.2%, of the participants who scored the highest mark were aged between 21-30 years old as compared to the 19.4% who were aged between 31- 40 years old. However, 55.0% of the participants who were awarded no marks were also aged between 21- 30 years old.

		Risk of man jumping out of lorry on the main road						Total
		0	**1**	**2**	**3**	**4**	**5**	
Age Group	**16-20**	4	2	2	5	2	2	17
	21-30	44	3	15	29	32	17	140
	31-40	14	0	6	13	17	7	57
	41-50	11	1	2	4	10	8	36
	51-59	5	1	1	4	5	1	17
	60-69	1	0	0	0	1	0	2
	71-80	1	0	0	1	0	1	3
Total		80	7	26	56	67	36	272

Table 8.7: Cross tabulation for the risk of a man jumping out of lorry on the main road against participant's age group

From Table 8.8, it could be found that 41.6% of the participants who scored five marks have a driving experience of more than 10 years where they were able to identify the risk of an individual to jump suddenly out of a lorry causing a developing hazard. However, 29.4% of the participants could not score any marks where 9.5% of them have a driving experience of less than two years, 5.2% have a driving experience between 3-5 years, 4.0% have a driving experience between 6-9 years and the remaining 10.7% have a driving experience of above 10 years.

		Risk of man jumping out of lorry on the main road						Total
		0	**1**	**2**	**3**	**4**	**5**	
Driving experience	**0 - 6 Months**	3	0	0	0	1	1	5
	6 Months - 1 Year	6	0	3	4	2	3	18
	1 - 2 Years	17	2	4	7	5	4	39
	3 - 5 Years	14	2	9	22	16	8	71
	6 - 9 Years	11	2	6	6	12	5	42
	More than 10 Years	29	1	4	17	31	**15**	97
Total		80	7	26	56	67	36	272

Table 8.8: Cross tabulation for the risk of a man jumping out of lorry on the main road against participant's driving experience

Risk of pedestrians to cross the road

Table 8.9 below displays the results that was obtained for the developing hazard, H1002 where there was the risk of pedestrians to cross the road. From the hazard perception test, it could be found that a majority of the participants who scored five marks, 72.5% were male and 27.5% were females. On the other hand, 14.3% of the participants were awarded no marks since they were not able to identify the developing hazard within the required time interval to take evasive actions.

		Risk of pedestrians to cross the road						Total
		0	**1**	**2**	**3**	**4**	**5**	
Gender	**Female**	8	2	2	7	29	17	65
	Male	31	10	10	30	81	45	207
Total		39	12	12	37	110	62	272

Table 8.9: Cross tabulation for the risk of pedestrians to cross the road against participant's gender

Table 8.10 below shows the cross tabulation for the risk of pedestrians to cross the road against the participant's age group. From the findings, it could be found that 54.8% of the participants, who scored the highest mark were aged between 21-30 years old. However, on the other hand, 38.4%, of the participants who were awarded no marks were aged above 31 years old where 17.9% were aged between 31- 40 years, 5.1% were aged between 41-50 years, 10.3% were aged between 51- 59 years and the remaining 5.1% were above the age of 60 years.

		Risk of pedestrians to cross the road						Total
		0	**1**	**2**	**3**	**4**	**5**	
Age Group	**16-20**	2	0	1	2	6	6	17
	21-30	22	4	4	14	62	34	140
	31-40	7	3	2	7	25	13	57
	41-50	2	2	4	7	14	7	36
	51-59	4	2	1	5	3	2	17
	60-69	1	1	0	0	0	0	2
	71-80	1	0	0	2	0	0	3
Total		39	12	12	37	110	62	272

Table 8.10: Cross tabulation for the risk of pedestrians to cross the road against participant's age group

Table 8.11 shows the result that was obtained for the risk of pedestrians to cross the road against the participant's driving experience. As such, it could be found that 22.8% of the participants who scored five marks, 5.9% of them have a driving experience of less than two years, 5.5% have a driving experience between 3-5 years, 4.0% have a driving experience between 6-9 years and 7.4% have a driving experience of more than 10 years. On the contrary, 14.3% of the participants could not identify the developing hazard and they were awarded no marks.

		Risk of pedestrians to cross the road						Total
		0	1	2	3	4	5	
Driving experience	**0 - 6 Months**	0	0	0	0	1	4	5
	6 Months - 1 Year	2	0	2	2	11	1	18
	1 - 2 Years	6	0	2	3	17	11	39
	3 - 5 Years	9	4	1	13	29	15	71
	6 - 9 Years	6	2	3	4	16	11	42
	More than 10 Years	16	6	4	15	36	20	97
Total		39	12	12	37	110	62	272

Table 8.11: Cross tabulation for the risk of pedestrians to cross the road against participant's driving experience

Risk of pedestrians with carriage stroller crossing the road

Table 8.12 below shows the results that was obtained for the developing hazard, H1003a where there was the risk of pedestrians with a carriage stroller to cross the road. From the findings, it could be found that a majority of the participants who scored five marks, 85.7% were male and 14.3% were females. On the other hand, 125 participants out of 272 were awarded no marks since they were not able to identify the developing hazard with the appropriate time frame.

		Risk of pedestrians with carriage stroller crossing the road						Total
		0	1	2	3	4	5	
Gender	**Female**	32	10	9	9	4	1	65
	Male	93	32	41	24	11	6	207
Total		125	42	50	33	15	7	272

Table 8.12: Cross tabulation for the risk of pedestrians with a carriage stroller to cross the road against participant's gender

Table 8.13 below shows the cross tabulation for the risk of pedestrians with a carriage stroller to cross the road against the participant's age group. From the findings, it could be found that most of the participants, 45.9% could not score any marks since they were not able to identify the developing hazard in due time. Within these research participants, 4.4% were aged between 16-20 years, 22.4% were aged between 21-30 years old, 8.1% were aged between 31- 40 years, 6.6% were aged between 41-50 years, 2.9% were aged between 51- 59 years and the remaining 1.5% were above the age of 60 years old. On the contrary, only 7 participants out of 272 were able to score the highest score of five marks.

		Risk of pedestrians with carriage stroller crossing the road						Total
		0	1	2	3	4	5	
Age Group	**16-20**	12	1	2	0	2	0	17
	21-30	61	26	25	16	8	4	140
	31-40	22	9	8	13	3	2	57
	41-50	18	4	10	2	2	0	36
	51-59	8	2	5	2	0	0	17
	60-69	2	0	0	0	0	0	2
	71-80	2	0	0	0	0	1	3
Total		125	42	50	33	15	7	272

Table 8.13: Risk of pedestrians with a carriage stroller to cross the road against participant's age group

Table 8.14 shows the result that was obtained for the risk of pedestrians with a carriage stroller to cross the road against the participant's driving experience. The findings shows that 2.6% of the participants who scored five marks, 0.7% of them have a driving experience between 3-5 years, 0.4% have a driving experience between 6-9 years and 1.5% have a driving experience of more than 10 years. On the contrary, 12.9% of the participants who could not score any marks have a driving experience of less than 2 years, 12.8% have a driving experience between 3-5 years, 5.9 % have a driving experience between 6-9 years and the other 14.3% have a driving experience of more than 10 years.

		Risk of pedestrians with carriage stroller crossing the road						Total
		0	1	2	3	4	5	
Driving experience	**0 - 6 Months**	2	1	0	1	1	0	5
	6 Months - 1 Year	9	6	0	2	1	0	18
	1 - 2 Years	24	2	8	3	2	0	39
	3 - 5 Years	35	12	14	6	2	2	71
	6 - 9 Years	16	7	8	6	4	1	42
	More than 10 Years	39	14	20	15	5	4	97
Total		125	42	50	33	15	7	272

Table 8.14: Risk of pedestrians with a carriage stroller to cross the road against participant's driving experience

Risk of pickup emerging at three-way intersection

Table 8.15 below displays the results that was obtained for the developing hazard, H1003b where there was the risk of a pickup to emerge at three-way intersection. From the findings, it could be observed that a majority of the participants who scored five marks, 82.4% were males and 17.6% were females. On the other hand, 119 participants out of 272 were awarded no marks since they were not able to identify the risk of a pickup to emerge at three-way intersection within the required time.

		Risk of pickup emerging at three-way intersection						Total
		0	1	2	3	4	5	
Gender	**Female**	27	2	9	13	11	3	65
	Male	92	2	25	41	33	14	207
Total		119	4	34	54	44	17	272

Table 0.15: Cross tabulation for the risk of a pickup emerging at three-way intersection against participant's gender

Table 8.16 below shows the cross tabulation for the risk of a pickup emerging at three-way intersection against participant's age group. From the findings, it could be found that most of the participants, 43.8% could not score any marks since they were not able to identify the developing hazard. Within these research participants, 3.3% were aged between 16-20 years, 19.5% were aged between 21-30 years old, 9.9% were aged between 31- 40 years, 7.0% were aged between 41-50 years, 2.9% were aged between 51- 59 years and the remaining 1.1% were above the age of 60 years old. On the other hand, only 17 participants out of 272 were able to score the highest score of five marks.

		Risk of pickup emerging at three-way intersection						
		0	1	2	3	4	5	Total
Age Group	**16-20**	9	0	3	4	1	0	17
	21-30	53	4	15	27	31	10	140
	31-40	27	0	5	13	10	2	57
	41-50	19	0	6	6	1	4	36
	51-59	8	0	3	4	1	1	17
	60-69	1	0	1	0	0	0	2
	71-80	2	0	1	0	0	0	3
Total		119	4	34	54	44	17	272

Table 8.16: Cross tabulation for the risk of a pickup emerging at three-way intersection against participant's age group

From Table 8.17, it could be found that 3.3% of the participants who scored five marks have a driving experience of more than 10 years where they were able to identify the risk of a pickup to suddenly emerge at a three-way intersection causing a developing hazard. However, 43.6% of the participants could not score any marks where 9.2% of them have a driving experience of less than two years, 9.6% have a driving experience between 3-5 years, 8.1% have a driving experience between 6-9 years and the remaining 16.9% have a driving experience of more than 10 years.

		Risk of pickup emerging at three-way intersection						
		0	1	2	3	4	5	Total
Driving experience	**0 - 6 Months**	4	0	0	1	0	0	5
	6 Months - 1 Year	6	1	1	5	5	0	18
	1 - 2 Years	15	0	6	8	9	1	39
	3 - 5 Years	26	1	13	14	13	4	71
	6 - 9 Years	22	2	4	7	4	3	42
	More than 10 Years	46	0	10	19	13	9	97

Total	119	4	34	54	44	17	272

Table 8.17: Cross tabulation for the risk of pickup emerging at three-way intersection against participant's driving experience.

Risk of roadside pedestrian to cross

Table 8.18 below displays the results that was obtained for the developing hazard, H1004 where there was the risk of pedestrians to cross the road. From the hazard perception test, it could be found that a majority of the participants who scored five marks, 83.3% were male and 16.6% were females. On the other hand, 14.7% of the participants were awarded no marks since they were not able to identify the developing hazard within the required time interval to take evasive actions.

		Risk of roadside pedestrian to cross						
		0	1	2	3	4	5	Total
Gender	**Female**	10	0	1	17	32	5	65
	Male	30	2	12	35	103	25	207
Total		40	2	13	52	135	30	272

Table 8.18: Cross tabulation for risk of pedestrians to cross the road against participant's gender

Table 8.19 below shows the cross tabulation for the risk of pedestrians to cross the road against the participant's age group. From the findings, it could be found that 14.7% of the participants could not score any marks since they were not able to identify the developing hazard in due time. As such, 1.8% were aged between 16-20 years, 8.8% were aged between 21-30 years old, 0.7% were aged between 31- 40 years, 1.8% were aged between 41-50 years, 1.5% were aged between 51- 59 years. Besides, 11.0% of the participants were able to score five marks where 1.1% were aged between 16-20 years, 5.1% were aged between 21-30 years old, 3.3% were aged between 31- 40 years, 1.1% were aged between 41-50 years and the other 0.4% were aged between 51- 59 years old.

		Risk of roadside pedestrian to cross						
		0	1	2	3	4	5	Total
Age Group	**16-20**	5	0	0	3	6	3	17
	21-30	24	0	6	26	70	14	140
	31-40	2	0	3	7	36	9	57
	41-50	5	1	2	10	15	3	36

	51-59	4	1	1	5	5	1	17
	60-69	0	0	1	1	0	0	2
	71-80	0	0	0	0	3	0	3
Total		40	2	13	52	135	30	272

Table 8.19: Cross tabulation for risk of pedestrians to cross the road against participant's age group

Table 8.20 displays the result that was obtained for the risk of pedestrians to cross the road against the participant's driving experience. As such, it could be found that 11.0% of the participants who scored five marks, 2.6% of them have a driving experience of less than two years, 2.9% have a driving experience between 3-5 years, 2.2% have a driving experience between 6-9 years and 3.3% have a driving experience of more than 10 years. On the contrary, 14.7% of the participants could not identify the developing hazard and they were awarded no score.

		Risk of roadside pedestrian to cross						Total
		0	1	2	3	4	5	
Driving experience	0 - 6 Months	3	0	0	1	0	1	5
	6 Months - 1 Year	3	0	0	2	11	2	18
	1 - 2 Years	5	0	1	9	20	4	39
	3 - 5 Years	10	0	2	12	39	8	71
	6 - 9 Years	9	0	6	7	14	6	42
	More than 10 Years	10	2	4	21	51	9	97
Total		40	2	13	52	135	30	272

Table 8.20: Cross tabulation for risk of pedestrians to cross the road against participant's driving experience.

Risk of car overtaking dangerously

Table 8.21 below shows the results that was obtained for the developing hazard, H1005 where there was the risk of a car to overtake dangerously. From the findings, it could be found that a majority of the participants who scored five marks, 84.6% were male and 15.4% were females. On the other hand, 152 participants out of 272 were awarded no marks since they were not able to identify the developing hazard with the appropriate time frame.

		Risk of car overtaking dangerously						Total
		0	1	2	3	4	5	
Gender	**Female**	37	2	4	10	10	2	65
	Male	115	7	23	30	21	11	207
Total		152	9	27	40	31	13	272

Table 8.21: Cross tabulation the risk of a car to overtake dangerously against participant's gender

Table 8.22 below shows the cross tabulation for the risk of a car to overtake dangerously against the participant's age group. From the findings, it could be found that more than half of the participants, 55.9% could not score any marks since they were not able to identify the developing hazard. Within this number, 2.5% were aged between 16-20 years, 32.7% were aged between 21-30 years old, 9.5% were aged between 31- 40 years, 7.3% were aged between 41-50 years, 3.3% were aged between 51- 59 years and the remaining 0.4% were above the age of 60 years old. On the contrary, 4.8% of the participants were able to score five marks.

		Risk of car overtaking dangerously						Total
		0	1	2	3	4	5	
Age Group	**16-20**	7	1	0	5	3	1	17
	21-30	89	5	9	16	17	4	140
	31-40	26	2	10	8	6	5	57
	41-50	20	0	6	6	4	0	36
	51-59	9	1	0	3	1	3	17
	60-69	1	0	1	0	0	0	2
	71-80	0	0	1	2	0	0	3
Total		152	9	27	40	31	13	272

Table 8.22: Cross tabulation the risk of a car to overtake dangerously against participant's age group

From Table 8.23, it could be observed that 55.9% of the participants were awarded no marks since they were not able to properly identity the risk of a car to overtake dangerously. Among these participants, 14.7% of them have a driving experience of less than 2 years, 15.7% have a driving experience between 3-5 years, 7.7% have a driving experience between 6-9 years and the other remaining 18.4% have more than 10 years of driving experience.

		Risk of car overtaking dangerously						Total
		0	**1**	**2**	**3**	**4**	**5**	
Driving experience	**0 - 6 Months**	1	1	0	1	2	0	5
	6 Months - 1 Year	13	0	1	1	3	0	18
	1 - 2 Years	26	1	0	7	4	1	39
	3 - 5 Years	41	3	6	11	8	2	71
	6 - 9 Years	21	1	4	6	7	3	42
	More than 10 Years	50	3	16	14	7	7	97
Total		152	9	27	40	31	13	272

Table 8.23: Cross tabulation the risk of a car to overtake dangerously against participant's driving experience

Risk of pedestrian crossing while talking on mobile phone

Table 8.24 below shows the results that was obtained for the developing hazard, H1006 where there was the risk of pedestrian to cross the road while talking on a mobile phone. From the findings, it could be found that a majority of the participants who scored five marks, 70.5% were male and 29.4% were females. On the other hand, 30.9% of the participants were awarded no marks since they were not able to identify the risk of a pedestrian to cross the road while talking on a mobile phone.

		Risk of pedestrian crossing while talking on mobile phone						Total
		0	**1**	**2**	**3**	**4**	**5**	
Gender	**Female**	19	10	9	11	11	5	65
	Male	65	27	45	38	20	12	207
Total		84	37	54	49	31	17	272

Table 8.24: Cross tabulation for the risk of pedestrian to cross the road while talking on mobile phone against participant's gender

Table 8.25 below shows the cross tabulation for risk of a pedestrian to cross the road while talking on a mobile phone against the participant's age group. From the findings, it could be found that 6.3% of the participants who scored the highest mark were aged between 21-69 years old. On the other extreme, 30.9%, of the participants who were awarded no marks were aged above 16 years old where 1.8% were aged between 16-20 years, 15.1% were aged between 21-30 years, 4.7% were aged between 31-40 years, 4.0% were aged between 41-50 years, 4.0% were aged between 51- 59 years and the remaining 1.1% were above the age of 60 years.

		Risk of pedestrian crossing while talking on mobile phone						Total
		0	1	2	3	4	5	
Age Group	**16-20**	5	4	1	5	2	0	17
	21-30	41	16	34	22	19	8	140
	31-40	13	11	7	15	7	4	57
	41-50	11	5	10	7	0	3	36
	51-59	11	1	2	0	2	1	17
	60-69	1	0	0	0	0	1	2
	71-80	2	0	0	0	1	0	3
Total		84	37	54	49	31	17	272

Table 8.25: Cross tabulation for the risk of pedestrian to cross the road while talking on mobile phone against participant's age group

From Table 8.26, it could be found that 6.3% of the participants who scored five marks have a driving experience of more than 1 year where they were able to identify the risk of a pedestrian to cross the road while talking on mobile phone causing a developing hazard. However, 30.9% of the participants could not score any marks where 7.7% of them have a driving experience of less than two years, 7.0% have a driving experience between 3-5 years, 3.3% have a driving experience between 6-9 years and the remaining 12.9% have a driving experience of above 10 years.

		Risk of pedestrian crossing while talking on mobile phone						Total
		0	1	2	3	4	5	
Driving experience	**0 - 6 Months**	2	2	0	1	0	0	5
	6 Months - 1 Year	6	2	5	1	4	0	18
	1 - 2 Years	13	6	8	7	3	2	39
	3 - 5 Years	19	9	16	10	12	5	71
	6 - 9 Years	9	8	9	10	3	3	42
	More than 10 Years	35	10	16	20	9	7	97
Total		84	37	54	49	31	17	272

Table 8.26: Cross tabulation for the risk of pedestrian to cross the road while talking on mobile phone against participant's age group

Risk of students to cross the road at three-way intersection

Table 8.27 below displays the results that was obtained for the developing hazard, H1007a where there was the risk of students to cross the road at three-way intersection. From the findings, it could be observed that the participants who scored five marks, 70.0% were males and 30.0% were females. On the other hand, 139 participants out of 272 were awarded no marks since they were not able to identify the risk of students to cross the road at three-way intersection within the appropriate time.

		Risk of students to cross the road at three-way intersection						Total
		0	1	2	3	4	5	
Gender	Female	36	7	8	10	1	3	65
	Male	103	30	31	24	12	7	207
Total		139	37	39	34	13	10	272

Table 8.27: Cross tabulation for risk of students to cross the road at three-way intersection against participant's gender

From the results in Table 8.28, it could be observed that nearly half of the number of participants who could not score any marks 4.7% were aged between 16-20 years, 26.1% were aged between 21-30 years, 8.8% were aged between 31-40 years, 7.0% were aged between 41-50 years, 2.9% were aged between 51- 59 years and the remaining 1.5% were above the age of 60 years as compared to 3.6% of the participants who scored five marks.

		Risk of students to cross the road at three-way intersection						Total
		0	1	2	3	4	5	
Age Group	16-20	13	3	0	0	1	0	17
	21-30	71	18	20	20	8	3	140
	31-40	24	7	11	10	1	4	57
	41-50	19	7	5	2	1	2	36
	51-59	8	1	3	2	2	1	17
	60-69	2	0	0	0	0	0	2
	71-80	2	1	0	0	0	0	3
Total		139	37	39	34	13	10	272

Table 8.28: Cross tabulation for risk of students to cross the road at three-way intersection against participant's age group

Table 8.29 displays the result that was obtained for the risk of students to cross the road at three-way intersection against the participant's driving experience. As such, it could be found that 3.7% of the participants who scored five marks, 0.7% of them have a driving experience of less than two years, 0.7% have a driving experience between 3-5 years, 0.4% have a driving experience between 6-9 years and 1.8% have a driving experience of more than 10 years. On the contrary, more than half of the participants, 51.1% could not identify the developing hazard and they were awarded no score.

		Risk of students to cross the road at three-way intersection						Total
		0	1	2	3	4	5	
Driving experience	0 - 6 Months	4	0	1	0	0	0	5
	6 Months - 1 Year	10	2	3	1	0	2	18
	1 - 2 Years	22	5	5	5	2	0	39
	3 - 5 Years	39	10	5	11	4	2	71
	6 - 9 Years	17	5	9	8	2	1	42
	More than 10 Years	47	15	16	9	5	5	97
Total		139	37	39	34	13	10	272

Table 0.29: Cross tabulation for risk of students to cross the road at three-way intersection against participant's driving experience

Risk of pickup turning right at three-way intersection

Table 8.30 below displays the results that was obtained for the developing hazard, H1007b where there was the risk of a pickup turning right at three-way intersection. From the findings, it could be observed that the participants who scored five marks, all of them were males. However, 39.3% of the participants were awarded no marks since they were not able to identify the developing hazard appropriately.

		Risk of pickup turning right at three-way intersection						Total
		0	1	2	3	4	5	
Gender	Female	19	9	28	9	0	0	65
	Male	88	14	70	27	4	4	207
Total		107	23	98	36	4	4	272

Table 8.30: Cross tabulation for risk of a pickup turning right at three-way intersection against participant's gender

Table 8.31 below shows the cross tabulation for the risk of a pickup turning right at three-way intersection against the participant's age group. From the findings, it could be found that 39.3% of the participants could not score any marks since they were not able to identify the developing hazard in due time. As such, 2.9% were aged between 16-20 years, 19.2% were aged between 21-30 years old, 8.1% were aged between 31- 40 years, 1.8% were aged between 41-50 years, 5.1% were aged between 51- 59 years and 0.7% were aged above 60 years old. Moreover, 1.4% of the participants who were able to score five marks were aged between 31-50 years.

		Risk of pickup turning right at three-way intersection						Total
		0	1	2	3	4	5	
Age Group	**16-20**	8	3	4	2	0	0	17
	21-30	52	9	51	25	3	0	140
	31-40	22	7	20	5	1	2	57
	41-50	14	4	13	3	0	2	36
	51-59	9	0	7	1	0	0	17
	60-69	2	0	0	0	0	0	2
	71-80	0	0	3	0	0	0	3
Total		107	23	98	36	4	4	272

Table 8.31: Cross tabulation for risk of a pickup turning right at three-way intersection against participant's age group

Table 8.32 displays the cross tabulation for the risk of a pickup turning right at three-way intersection against the participant's driving experience. From the results, it could be found that 9.2% of the participants could not score any marks have a driving experience between 6 months to 2 years, 9.2% have a driving experience between 3 to 5 years, 6.3% having a driving experience between 6 to 9 years and 14.7% have a driving experience of more than 10 years. On the other hand, four of the participants, 1.5% who was awarded the highest score had a driving experience of more than 10 years.

		Risk of pickup turning right at three-way intersection						Total
		0	1	2	3	4	5	
Driving experience	**0 - 6 Months**	0	1	3	1	0	0	5
	6 Months - 1 Year	5	3	7	3	0	0	18
	1 - 2 Years	20	3	12	4	0	0	39
	3 - 5 Years	25	7	29	9	1	0	71
	6 - 9 Years	17	4	12	7	2	0	42
	More than 10 Years	40	5	35	12	1	4	97
Total		107	23	98	36	4	4	272

Table 8.32: Cross tabulation for risk of a pickup turning right at three-way intersection against participant's driving experience

Risk of road worker to cross the road

Table 8.33 below shows the results that was obtained for the developing hazard, H1008 where there was the risk of a road worker to cross the road. From the findings, it could be observed that the participants who scored five marks, all of them were males. Besides, a majority of the participants, 63.6% were awarded no marks where 46.0% were males and 17.6% were females since they were not able to identify the developing hazard with the appropriate time frame.

		Risk of road worker to cross the road						
		0	**1**	**2**	**3**	**4**	**5**	Total
Gender	**Female**	48	12	2	1	2	0	65
	Male	125	54	22	0	2	4	207
Total		173	66	24	1	4	4	272

Table 8.33: Cross tabulation for risk of road worker to cross the road against participant's gender

Table 8.34 below shows the cross tabulation for the risk of road worker to cross the road against participant's age group. From the findings, it could be found that 63.6% of the participants could not score any marks since they were not able to identify the developing hazard. Within this number, 4.4% were aged between 16-20 years, 33.5% were aged between 21-30 years old, 12.5% were aged between 31- 40 years, 8.8% were aged between 41-50 years, 3.7% were aged between 51- 59 years and the remaining 0.7% were above the age of 60 years old. On the other hand, 1.7% of the participants were able to score five marks.

		Risk of road worker to cross the road						
		0	**1**	**2**	**3**	**4**	**5**	Total
Age Group	**16-20**	12	4	0	0	1	0	17
	21-30	91	37	9	1	1	1	140
	31-40	34	13	7	0	2	1	57
	41-50	24	9	3	0	0	0	36
	51-59	10	1	5	0	0	1	17
	60-69	0	1	0	0	0	1	2
	71-80	2	1	0	0	0	0	3
Total		173	66	24	1	4	4	272

Table 0.34: Cross tabulation for risk of road worker to cross the road against participant's age group

From Table 8.35, it could be observed that 63.6% of the participants were awarded no marks since they were not able to properly identity the risk of a road worker to cross the road. Among these participants, 15.8% of them have a driving experience of less than 2 years, 16.9% have a driving experience between 3-5 years, 9.5% have a driving experience between 6-9 years and the other remaining 21.3% have more than 10 years of driving experience.

		Risk of road worker to cross the road						Total
		0	1	2	3	4	5	
Driving experience	0 - 6 Months	4	0	0	0	1	0	5
	6 Months - 1 Year	8	7	3	0	0	0	18
	1 - 2 Years	31	7	0	0	0	1	39
	3 - 5 Years	46	18	5	1	0	1	71
	6 - 9 Years	26	11	5	0	0	0	42
	More than 10 Years	58	23	11	0	3	2	97
Total		173	66	24	1	4	4	272

Table 8.35: Cross tabulation for risk of road worker to cross the road

Risk of cyclist emerging suddenly from branch into main road

Table 8.36 below shows the results that was obtained for the developing hazard, H1009 where there was the risk of a cyclist to emerge suddenly from a branch road into the main road. From the results, it could be found that 12 participants who scored five marks, 75.0% were males and 25.0% were females. On the other hand, 3.3% of the participants were awarded no marks since they were not able to identify the cyclist to emerge suddenly from a branch road causing developing hazard.

		Risk of cyclist emerging suddenly from branch into main road						Total
		0	1	2	3	4	5	
Gender	Female	3	3	19	27	10	3	65
	Male	6	13	68	78	33	9	207
Total		9	16	87	105	43	12	272

Table 8.36: Cross tabulation for the risk of a cyclist to emerge suddenly from a branch road into the main road against participant's gender

Table 8.37 below shows the cross tabulation for risk of a cyclist to emerge suddenly from a branch road into the main road against the participant's age group. From the findings, it could be found that 54.8% of the participants who scored the highest mark were aged between 21-30 years old. However, 38.4%, of the participants who were awarded no marks were aged above 31 years old where 17.9% were aged between 31- 40 years, 5.1% were aged between 41-50 years, 10.3% were aged between 51- 59 years and the remaining 5.1% were above the age of 60 years.

	Risk of cyclist emerging suddenly from branch into main road						Total
	0	1	2	3	4	5	

Age Group	**16-20**	2	0	4	6	4	1	17
	21-30	1	3	34	64	29	9	140
	31-40	3	5	19	20	8	2	57
	41-50	1	3	18	13	1	0	36
	51-59	1	2	11	2	1	0	17
	60-69	1	1	0	0	0	0	2
	71-80	0	2	1	0	0	0	3
Total		9	16	87	105	43	12	272

Table 8.37: Cross tabulation for the risk of a cyclist to emerge suddenly from a branch road into the main road against participant's age group

From Table 8.38, it could be found that only 4.4% of the participants were able to score five marks. Among these participants, 2.9% have a driving experience of more than 3 years and the other 1.5% have a driving experience between 6 months to 2 years. A majority of the participants, 38.6% scored three marks where 8.5% have a driving experience of less than 2 years, 13.2% have a driving experience between 3-5 years, 5.9% have a driving experience between 6-9 years and 11.0% have a driving experience of more than 10 years.

		Risk of cyclist emerging suddenly from branch into main road						Total
		0	**1**	**2**	**3**	**4**	**5**	
Driving experience	**0 - 6 Months**	1	0	1	2	1	0	5
	6 Months - 1 Year	0	0	6	5	6	1	18
	1 - 2 Years	1	0	10	16	9	3	39
	3 - 5 Years	0	5	17	36	11	2	71
	6 - 9 Years	2	2	15	16	5	2	42
	More than 10 Years	5	9	38	30	11	4	97
Total		9	16	87	105	43	12	272

Table 8.38: Cross tabulation for the risk of a cyclist to emerge suddenly from a branch road into the main road against participant's driving experience.

Risk of car reversing on main

Table 8.39 below displays the results that was obtained for the developing hazard, H10010 where there was the risk of a car to reverse on main road. From the hazard perception test, it could be found that the participants who scored five marks, 62.5% were male and 37.5% were females.

On the other hand, 29.0 % of the participants were awarded no marks since they were not able to identify the developing hazard within the required time interval to take evasive actions.

		Risk of car reversing on main						Total
		0	1	2	3	4	5	
Gender	**Female**	21	7	12	15	7	3	65
	Male	58	24	42	55	23	5	207
Total		79	31	54	70	30	8	272

Table 8.39: Cross tabulation for the risk of car reversing on main against participant's gender

Table 8.40 below shows the cross tabulation for the risk of a car to reverse on main road against participant's age group. From the findings, it could be found that most of the participants, 29.0% could not score any marks since they were not able to identify the developing hazard. Within these research participants, 2.2% were aged between 16-20 years, 14.3% were aged between 21-30 years old, 2.9% were aged between 31- 40 years, 5.5% were aged between 41-50 years, 3.3% were aged between 51- 59 years and the remaining 0.7% were above the age of 60 years old. On the other hand, only 8 participants out of 272 were able to score the highest score of five marks.

		Risk of car reversing on main						Total
		0	1	2	3	4	5	
Age Group	**16-20**	6	1	3	3	3	1	17
	21-30	39	17	22	40	16	6	140
	31-40	8	6	16	18	9	0	57
	41-50	15	3	12	5	1	0	36
	51-59	9	4	1	2	0	1	17
	60-69	2	0	0	0	0	0	2
	71-80	0	0	0	2	1	0	3
Total		79	31	54	70	30	8	272

Table 8.40: Cross tabulation for the risk of car reversing on main against participant's age group

Table 8.41 displays the cross tabulation for the risk of a car to reverse on main road against the participant's driving experience. From the results, it could be found that 7.35% of the participants could not score any marks have a driving experience between 6 months to 2 years, 8.1% have a driving experience between 3 to 5 years, 4.4% having a driving experience between 6 to 9 years and 9.2% have a driving experience of more than 10 years. On the other hand, 8 of the participants, 2.9% were awarded the highest score where 0.4% had a driving experience between 6 months to 2 years, 2.2% had a driving experience between 3 to 5 years and 0.4% had a driving experience above 10 years.

		Risk of car reversing on main						Total
		0	1	2	3	4	5	
Driving experience	**0 - 6 Months**	3	0	1	0	1	0	5
	6 Months - 1 Year	5	3	2	6	1	1	18
	1 - 2 Years	12	5	6	10	6	0	39
	3 - 5 Years	22	9	8	22	4	6	71
	6 - 9 Years	12	4	5	12	9	0	42
	More than 10 Years	25	10	32	20	9	1	97
Total		79	31	54	70	30	8	272

Table 8.41: Cross tabulation for the risk of car reversing on main against participant's age group

Risk of car changing lane suddenly on motorway

Table 8.42 below displays the results that was obtained for the developing hazard, H10011 where there was the risk of a car changing lane suddenly on the motorway. From the findings, it could be observed that a majority of the participants who scored five marks, 71.4% were male and 28.5% were females. On the other hand, 134 participants out of 272 were awarded no marks since they were not able to identify the risk of a car changing lane suddenly on the motorway leading to a developing hazard.

		Risk of car changing lane suddenly on motorway						Total
		0	1	2	3	4	5	
Gender	**Female**	33	11	7	6	4	4	65
	Male	101	56	19	8	13	10	207
Total		134	67	26	14	17	14	272

Table 8.42: Cross tabulation for the risk of car changing lane suddenly on motorway against participant's gender

Table 8.43 below shows the cross tabulation for the risk of a car changing lane suddenly on motorway against participant's age group. From the findings, it could be found that nearly half of the participants, 49.3% could not score any marks since they were not able to identify the developing hazard. Within this number, 4.8% were aged between 16-20 years, 24.3% were aged between 21-30 years old, 9.5% were aged between 31- 40 years, 5.5% were aged between 41-50 years, 3.6% were aged between 51- 59 years and the remaining 1.5% were above the age of 60 years old. On the contrary, 5.1% of the participants were able to score five marks.

		Risk of car changing lane suddenly on motorway						Total
		0	1	2	3	4	5	
Age Group	**16-20**	13	1	1	0	1	1	17
	21-30	66	32	12	8	14	8	140
	31-40	26	19	7	3	1	1	57
	41-50	15	11	4	3	1	2	36
	51-59	10	3	2	0	0	2	17
	60-69	2	0	0	0	0	0	2
	71-80	2	1	0	0	0	0	3
Total		134	67	26	14	17	14	272

Table 8.43 Cross tabulation for the risk of car changing lane suddenly on motorway against participant's age group

From Table 8.44, it could be observed that 49.3% of the participants were awarded no marks since they were not able to properly identity the risk of a car to change lane suddenly on a motorway. Among these participants, 12.9% of them have a driving experience of less than 2 years, 11.8% have a driving experience between 3-5 years, 7.4% have a driving experience between 6-9 years and the other remaining 17.3% have more than 10 years of driving experience.

		Risk of car changing lane suddenly on motorway						Total
		0	1	2	3	4	5	
Driving experience	**0 - 6 Months**	3	1	0	0	0	1	5
	6 Months - 1 Year	11	2	2	0	1	2	18
	1 - 2 Years	21	8	3	3	3	1	39
	3 - 5 Years	32	18	5	5	7	4	71
	6 - 9 Years	20	10	3	3	2	4	42
	More than 10 Years	47	28	13	3	4	2	97
Total		134	67	26	14	17	14	272

Table 8.44: Cross tabulation for the risk of car changing lane suddenly on motorway against participant's driving experience