Faculty of Engineering

Modeling on the Likelihood of Driving Errors Due to Distracted Driving Behaviour (DDB) Associated with Mobile Phone Usage in Malaysia

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DECLARATION

I Melissa Lee May Syn, 15020343, Faculty of Engineering hereby declare that the work entitled Modeling on the Likelihood of Driving Errors Due to Distracted Driving Behaviour (DDB) Associated with Mobile Phone Usage in Malaysia is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person. The thesis has not been accepted for any degree and is not concurrently submitted in candidature for any other degree.

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Date Submitted

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ABSTRACT

The use of mobile phone while driving has become an addiction in today's society which leads to the increase of mobile phone-related road crashes. As such, the research into mobile phone-related distractions have attracted much attention and become increasingly prominent. Although it has been found that this behaviour leads to driving errors, the relationship between different types of mobile phone usage and the different categories of driving errors such as road violations (RV), cognitive errors (CE) and action errors (AE) requires in-depth exploration, at least in the Malaysian context. Thus, this research aimed to examine the likelihood of driving errors due to distracted driving behaviour (DDB) associated with mobile phone usage in Malaysia. Through a self-administered questionnaire, the data obtained from 624 respondents were analysed. The results provided evidence that DDB, regardless of making phone calls or texting, was significantly affecting RV, CE and AE. For making a phone call while driving, binary logistic regression results revealed that the factors that influenced the respondents to perform red-light running (RV) are the frequency of usage (very frequently), occupation (sales/marketing) and traffic conditions (driving on a straight road). The lane excursion (CE) is influenced by the following: occupation (accounting/finance and building/construction) and driving experience, whilst for the factors which lead to the failure in indicating when turning (AE) are occupation (arts/media/communications), traffic conditions (driving on a straight road and slow moving traffic) and driving experience. Meanwhile, for texting while driving, the following are associated with the increased likelihood of red-light running (RV): frequency of usage (very frequently, fairly often and on a few occassions), traffic conditions (driving on a straight road) and occupation (sales/marketing). Besides, it was also found that factors such as

frequency of usage (very frequently, fairly often, on a few occasions) and driving experience are related to CE (lane excursions), whereas another CE (brake late and hard) is affected by the frequency of usage (very frequently, fairly often and on a few occasions). Lastly, AE (fail to indicate when turning) is associated with traffic conditions (driving on a straight road), occupation (sales/marketing) and traffic conditions (slow-moving traffic). Hence, it can be concluded that driving can lead to more driving errors compared to making a phone call. Evidently, the findings provide a useful insight on the DDB associated with mobile phone usage in order to deploy more effective prevention strategies and treatments, besides providing a platform for future research.

Keywords: Distracted driving behaviour (DDB), mobile phone usage, driving errors

Pemodelan Kesalahan Memandu yang Disebabkan oleh Kelakuan Memandu yang Terganggu dengan Penggunaan Telefon Bimbit di Malaysia

ABSTRAK

Penggunaan telefon bimbit ketika memandu telah menjadi lumrah dalam kalangan masyarakat hari ini yang juga merupakan salah satu lagi penyebab kepada peningkatan kemalangan jalan raya. Sehubungan dengan itu, kajian ke atas gangguan telefon bimbit telah menarik perhatian daripada pelbagai pihak. Walaupun pelbagai penyelidikan telah membuktikan kelakuan ini akan menyebabkan kesalahan memandu, hubungan antara pelbagai jenis penggunaan telefon bimbit dan kategori kesalahan memandu yang berbeza seperti pelanggaran jalan, kesalahan kognitif dan kesalahan tindakan memerlukan penerokaan mendalam, sekurang-kurangnya dalam konteks Malaysia. Sedemikian, penyelidikan ini bertujuan untuk mereka model kesalahan memandu yang disebabkan oleh kelakuan memandu yang terganggu dengan penggunaan telefon bimbit di Malaysia. Melalui borang soal selidik, maklum balas yang diperoleh daripada 624 responden telah dianalisis. Hasil kajian menunjukkan bahawa penggunaan telefon bimbit, iaitu panggilan telefon dan penghantaran mesej akan menyebabkan kesalahan memandu dari segi pelanggaran jalan, kesalahan kognitif dan kesalahan tindakan. Dengan menggunakan model regresi logistik binari, angkubah yang meramal pelanggaran jalan (lampu isyarat) semasa panggilan telefon adalah kekerapan penggunaan (sangat kerap), pekerjaan ('sales/marketing') dan keadaan trafik (memandu di jalan lurus, manakala pekerjaan ('accounting/finance' dan 'building/construction') dan pengamalan memandu dihubungkait dengan kesalahan kognitif (pandu ke lorong lain). Angkubah bagi kesalahan tindakan (kegagalan memberi isyarat semasa membelok) ialah pekerjaan ('arts/media/communications'), keadaan trafik (memandu ketika di jalan lurus dan semasa aliran trafik perlahan) dan pengalaman

memandu. Selain itu, bagi kesalahan memandu semasa penghantaran mesej pula, pelanggaran jalan (lampu isyarat) dihubungkait dengan kekerapan penggunaan (sangat kerap), keadaan trafik (memandu di jalan lurus), pekerjaan ('sales/marketing'), kekerapan penggunaan (agak kerap dan kadang-kala dan pengalaman memandu. Seterusnya, angkubah bagi kesalahan kognitif (pandu ke lorong lain) ialah kekerapan penggunaan (sangat kerap, agak kerap dan kadang-kala) dan pengalaman memandu, manakala bagi brek lewat (kesalahan kognitif) pula dikaitkan dengan kekerapan penggunaan (sangat kerap, agak kerap dan kadang-kala). Akhir sekali, angkubah seperti keadaan trafik (memandu di jalan lurus), pekerjaan ('sales/marketing') dan keadaan trafik (semasa aliran trafik perlahan) didapati menjejaskan kesalahan tindakan (kegagalan memberi isyarat semasa membelok). Oleh itu, penghantaran mesej semasa memandu boleh menyebabkan lebih banyak kesalahan memandu berbanding dengan panggilan telefon. Keseluruhannya, penemuan daripada projek penyelidikan ini berjaya memberi informasi tentang pengunaan telefon bimbit dan gangguan yang ditimbulkan ketika memandu. Justeru, pendekatan yang lebih berkesan bakal dilaksanakan untuk mencegah dan membendung isu ini sehingga ke akar umbinya. Usaha ini juga bertujuan untuk meningkatkan kualiti hasil penyelidikan pada masa depan.

Kata kunci: *Kesalahan memandu, kelakuan memandu, penggunaan telefon bimbit*

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LIST OF ABBREVIATIONS

AAMI	Australian Associated Motor Insurers Limited
CDC	Centers for Disease Control and Prevention
DDB	Distracted Driving Behaviour
DOT	United States Department of Transportation
GHSA	Governors Highway Safety Association
JKJR	*Jabatan Keselamatan Jalan Raya*
JPJ	*Jabatan Pengangkutan Jalan*
MIROS	Malaysian Institute of Road Safety Research
NCSA	National Center for Statistics and Analysis
NDS	Naturalistic Driving Study
NHTSA	National Highway Traffic Safety Administration
NSC	National Safety Council
NTLC	National Traffic Law Center
RMP	Royal Malaysia Police
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organization

LIST OF SYMBOLS

β	Coefficient of Constant
df	Degree of Freedom
e^{β}	Odds Ratio
p	Probability Value
SE β	Standard Error of Coefficient of Constant
Wald x^2	Wald Chi-Square Statistic

CHAPTER 1

INTRODUCTION

This chapter presents a basic review of the research background and phenomenon, the problem being studied, the formulated research questions, research aim and specific objectives, expected hypothesis, the scope of research involved throughout the period of study, as well as the significance of the research.

1.1 Background

Nowadays, road traffic crashes are one of the major and leading socioeconomic issues in both developing and developed countries. From the Global Status Report on Road Safety 2015, World Health Organization (2015) has recognised and ranked road traffic crashes as the ninth leading cause of astounding death throughout the world, accounting for nearly 1.25 million people being killed while travelling on the road, and another 20 to 50 million sustaining from non-fatal injuries each year. Interestingly, this phenomenon has been found to have severe impact on low-income and middle-income countries, particularly where the rapid motorization has not been accompanied sufficiently by the improved road transport infrastructure and up-to-date road safety schemes. Consequently, both the low-income and middle-income countries have the recorded death rate exceeding 90 percent, more than double that of high-income countries. Aside from the daunting figure, it is predicted that by 2030, road traffic crashes would become a very serious threat and escalate to become the seventh most frequent cause of death around the globe (WHO, 2015).

From the economic point of view, the monumental amount of casualties is not only imposing huge and intangible losses to the society, but to the nation as well (Blincoe, Miller, Zaloshnja & Lawrence, 2015; WHO, 2015). The economic costs are often in terms of property damage, lost productivity in both market and household, medical, emergency service (EMS), congestion, legal and court, insurance administration, as well as workplace losses (Blincoe et al., 2015). For example, it was reported that the government of the United States spent more than 380 million in medical costs on the lethal road traffic crashes which have occurred in 2013 (Centers for Disease Control and Prevention, 2016).

Having the similar situation in Malaysia, road traffic crashes ranked number four among the top causes of death in the country, after coronary heart disease, stroke, and influenza and pneumonia, respectively (Jaafar, 2015; WHO, 2014). Recent evidence suggested that the number of motor vehicle crashes has steadily increased over the years, in spite of the fact that many road safety campaigns have been carried out continuously by the government agencies. Unsurprisingly, the government is facing a large deficit in dealing with the road traffic crashes annually. According to The Star (2017), a total of RM9.21 billion was spent on the economic repercussions of fatal, serious and minor injury crashes in 2016, compared to the previous year (estimated at RM8.63 billion in 2015).

As indicated by the annual road traffic incident statistics, the figure has significantly increased from 250,429 to 521,466, which contributed to a notable increase of approximately 108.2 percent from the period between 2000 and 2016. Of the 521,466 motor vehicle crashes occurred in 2016 alone, a total of 7,152 fatalities was reported. This reflected an increment of nearly 6.7 percent (or equivalent to 446 fatalities), in comparison to the 6,706 people, which were killed in fatal accidents of the year 2015. Such phenomenon appeared to be disastrous as it has also resulted in the upsurge of mortality rate from 2.55 per 10,000 registered vehicles in 2015 to 2.59 per 10,000 registered vehicles in 2016 (Malaysian Institute of Road Safety Research, 2017).

In view of the trend, numerous research have investigated the critical factors which contribute to, or are associated with road traffic incidents. The National Highway Traffic Safety Administration (2018) has found that the occurrence of road incidents were due to alcohol impairment, drive under the influence of drugs, distracted driving, speeding, non-use of seat belts and drowsy driving. In the recent years, driver distraction has been identified as one of the most frequently reported inappropriate driving behaviour (Carter, Bingham, Zakrajsek, Shope & Sayer, 2014; Foss & Goodwin, 2014; Schroeder, Meyers & Kostyniuk, 2013) which have led to an alarming rise in fatality rates in distraction-affected crashes (Centers for Disease Control and Prevention, 2017; National Center for Statistics and Analysis, 2016; 2017). For example, in 2015, distraction-affected fatal crashes accounted for 10% (or equivalent to 3,196 cases) of all 32,166 fatal crashes in the United States. It was also reported that the number of fatalities amounting from 3,179 to 3,477 for the period from 2014 to 2015. Although there have been a slight decline of approximately 9.3% (from 431,000 to 391,000 cases) in the number of injury crashes, a high proportion can still be observed, thus revealed a worrisome trend (National Center for Statistics and Analysis, 2016; 2017).

Klauer et al. (2014) mentioned that distracted driving is the "diversion of attention away from activities critical for safe driving toward a competing activity". According to the Road Safety Committee (2006), the non driving-related activities or tasks can occur inside the vehicle (internal) and outside the vehicle (external). These include, initiating or answering phone calls, conversing with other passengers in the vehicle, attending to children, changing radio channels, adjusting CD, grooming, reading maps or directions, eating and drinking, smoking, using GPS (in-vehicle navigation system), connected to wireless internet or even outside person, object or event at the time of the crash (Stutts, Reinfurt, Staplin &

Rodgma, 2001). Thus, it is said that when the drivers perform secondary activities concurrently with the primary driving task, their attention will be disrupted; even worse, it results in the degradation of driving performance and consequently induces a much greater impacts on road safety. In addition, the increasing popularity of the use of electronic gadgets, particularly smart mobile phone has attracted much attention with regard to the safety implications of engaging such device behind the wheel. While the law is very clear at prohibiting the use of mobile phone (phone call and texting/reading) while driving, many road users however are still ignorant and infringing the traffic law related to the use of mobile phone while driving.

1.2 Problem Statement

The advancement of technological devices has led to the growth in mobile phone ownership over time. As such, the number of mobile phone usage while driving has risen considerably at an extraordinary pace. Apart from texting and emailing, the drivers are frequently accessing social media networks such as Facebook, Twitter, Instagram, Snapchat and an endless variety of applications which encourage a multitude of additional distracting activities while driving. Doubtlessly, the evolution of communications-based technology, especially smartphones integrated with social media application services will continue to tax a safety threat among the road users (AT&T, 2015; Governors Highway Safety Association, 2013). This is because it has been conclusively shown that, the motorists tend not to be aware of the magnitude of distractions and perceived risks of road traffic incidents when driving under mobile phone distractions (Walsh, White, Hyde & Watson, 2008). As a result of these interactions, frequent and prolonged eyes away from the roadway jeopardize safe driving and predispose even more devastating road traffic crashes throughout the world. In the

United States, for example, it was estimated that 25% of the overall traffic accidents or equivalent to 1.3 million of all vehicular crashes per annum was resulted from drivers talking on mobile phones or texting while driving in 2011. Of these alarming figures, approximately 1.1 million involved in mobile phone conversations, and another 200,000 crashes involved texting while driving (National Safety Council, 2013). In view of the trend, the NSC has urged to forbid the use of mobile phone while driving, regardless of handheld or hands-free devices.

Understanding distracted driving behaviour (DDB) remains an important area of road safety research, there have been an increasing amount of literature investigated on DDB and its corresponding impacts on various types of driving performance errors. However, the findings from these studies (Cooper & Zheng, 2002; Cooper et al., 2003; Hancock, Lesch & Simmons, 2003; Harrison, 2011; Horrey, Lesch & Garabet, 2008; Hosking, Young & Regan, 2009; Owens, McLaughlin & Sudweeks, 2011; Strayer, Drews & Johnston, 2003; Tractinsky, Ram & Shinar, 2013) have not fully explained how and to what extent different types of mobile phone distractions while driving affecting different category of driving errors. In other words, the correlation or the link between the different form of distractions associated with mobile phone usage and different type of driving errors are not clear, and thus requires further quantification. As such, a more comprehensive study ought to be undertaken to estimate the relationships of various types of DDB such as phone call and texting on driving errors.

In Malaysia, cheaper mobile phone and the wide coverage of internet service providers have also resulted in a considerable increase of mobile phone usage while driving among motorists. It can be clearly observed that many drivers, especially the younger generations nowadays are compromising their safety by actively engaging in mobile phone usage while driving. This is consistent with Isa et al. (2012) study, which concluded that the use of mobile phone while driving is common among young adults in Malaysia. While the body of research looking at the risks associated with DDB is growing rapidly in other parts of the world, there is much less known about such phenomena due to mobile phone use in Malaysia. Although the outcomes of the in-depth investigation by MIROS have shown that a number of significant factors contributed to road traffic crashes in Malaysia, up to date, no information could be retrieved to relate such behaviour to mobile phone usage-affected crashes.

Other than that, some of the approaches utilized in the previous DDB studies have been found to possess shortcomings which may bias the results. For example, McCartt, Hllinga and Bartiman (2006) and Papantoniou (2015) concluded that driving simulator, in spite of its strength in the ability to define various phone tasks on the driving tasks, the limitations are: (1) the experimental nature of simulation study offers less accuracy than that of real-world driving; (2) the data may be affected by the effects while participants are learning to use the simulator, as well as the presence of the experimenter when the study is being conducted; (3) the high-fidelity simulator is very expensive to be installed; and (4) simulator discomfort is encountered, and this effect is especially obvious among older drivers.

The downside of on-road study is often associated with a higher cost. Besides, this type of study is found to be greatly affected by different traffic conditions, as well as the inconsistent driving demands of the driver when performing each test drive, especially when the driver is not competent (Ball & Ackerman, 2011). Not only that, the presence of in-vehicle observers may possess impacts on the driver behaviour due to the fact that they are being monitored.

In 2006, McCartt et al. has identified several disadvantages of utilizing naturalistic driving in a research. Apart from being costly, this research method may affect the behaviours of driving as the participants are aware that they are being monitored, and thus, results can be inaccurate or untrue. Moreover, the criticism being raised is that, the correlation between the variables and road user behaviour is determined, instead of the unambiguous causal relationships due to the non-experimental control of variables (Van Schagen & Sagberg, 2012). Lastly, the participants may not be representative of the overall population of interest, given that NDS are often voluntary-based (Van Schagen, De Craen, Van Nes & Eenink, 2010).

Meanwhile, for crash-based study, the drawback is associated with the absence of data on the occurrence of DDB, especially the use of mobile phone while driving. This under-reporting has also been agreed by Ranney (2008), who mentioned that the drivers are typically reluctant to admit that they were engaging in DDB, particularly if the involvement may have contributed to a crash, when lodging a report.

Additionally, plenty of strategic approaches have been introduced to reduce the injury and mortality burden caused by this multifaceted issue, nonetheless the final outcomes are yet to attain positive results. The study findings from this research, therefore, play an important role in order to fathom on why such risky driving behaviour is getting serious in Malaysia, as well as to pinpoint how such behaviour could influence the drivers' driving errors which will then lead to road crashes. This is to ensure that a safe driving environment can be achieved, in an effort to reduce the distracted driving-related crashes, and subsequently halve the national death rate.

1.3 Research Questions

In this study, the likelihood of driving errors due to DDB associated with mobile phone usage is examined, and guided by the following three research questions (RQ's):

RQ1. What is the pattern of DDB associated with mobile phone usage in Malaysia?

RQ2. How different types of DDB (phone call and texting) influencing different categories of driving errors (road violations, cognitive errors and action errors)?

RQ3. What are the significant DDB variables (age, gender, occupation, driving experience, frequency of usage and traffic conditions) associated with mobile phone usage in predicting the likelihood of driving errors (road violations, cognitive errors and action errors)?

1.4 Research Aim and Research Objectives

The primary aim of this research is to modeling on the likelihood of driving errors due to DDB associated with mobile phone usage in Malaysia. Accordingly, in order to achieve the aim, this research is poised to undertake the three following research objectives:

i. to investigate the pattern of DDB associated with mobile phone usage in Malaysia.

ii. to examine the relationship between different types of driving errors (road violations, cognitive errors and action errors) with DDB associated with mobile phone usage (phone call and texting).

iii. to develop a statistical model in predicting the likelihood of driving errors (road violations, cognitive errors and action errors) under different types of DDB associated with mobile phone usage (phone call and texting).

1.5 Research Hypothesis

To measure the likelihood of the driving errors due to DDB associated with mobile phone usage, the following hypotheses are proposed and tested:

H1. There is a positive and significant relationship between different types of mobile phone associated DDB (phone call) and driving errors (road violations, cognitive errors and action errors).

H2. There is a positive and significant relationship between different types of mobile phone associated DDB (texting) and driving errors (road violations, cognitive errors and action errors).

1.6 Scope of Research

The present study sought to examine the different types of mobile phone-related DDB (phone call and texting) in influencing of three different categories of driving errors (road violations, cognitive errors and action errors). A self-administered questionnaire was undertaken on a pool of respondents which have met the criteria in two chosen locations, which were Kuching City and Kuala Lumpur, respectively. However, a pre-test and pilot test were conducted prior to the field study (actual survey) in order to validate the questionnaire instruments. The data collected from the actual survey were analysed to discover the errors typically made by drivers, and binary logistic regression was then performed using *IBM Statistical Package for the Social Sciences (SPSS) Statistics 21* to predict the independent variables such as age, gender, occupation, driving experience, frequency of usage and traffic conditions on the likelihood of occurrence of different types of driving errors. The independent variables were identified from the past research findings which have shown statistical significant results. This is in fact crucial in testing the two research hypotheses which have been mentioned in the previous section.

1.7 Significance of the Research

This research is significant in providing an overview of the DDB associated with mobile phone usage in Malaysia. The results of this research could provide a better understanding of the rampant trend of inappropriate use of mobile phones while driving among the drivers. Besides, the corresponding driver errors sustained by an individual, as well as the other variables that might affect the likelihood of the errors pertaining to each mobile phone activity while driving, could be identified and established accurately.

The final outcomes of the analysis would be beneficial to the government and local authorities in reviewing the road safety policy. The current Road Safety Plan of Malaysia 2014-2020, has not found to focus on the strategies to curb this expanding problem. Therefore, the determination of the potential safety measures regarding mobile phone usage while driving ought to be urgently addressed in a comprehensive fashion. For example, Jabatan Keselamatan Jalan Raya (JKJR) and the MIROS could use the evidence from the study in proposing various effective prevention and intervention programs, and along the way, to be undertaken continuously so as to enhance the road traffic safety awareness among the vulnerable road users while travelling on the roads. Moreover, Jabatan Pengangkutan Jalan (JPJ) could figure out alternative ways to strengthen the traffic laws on the prohibition of the use of mobile phone while driving. Simultaneously, and within this framework, the reduction of the high-incidence distracted driving-related crashes could be assured. This is equally important in supporting the Malaysian government efforts to significantly reduce road crash fatality target by 2020.

Additionally, it is believed that by conducting this study with the adopted approach, it will be both pivotal and beneficial for future research in the related areas, as well as on a bigger scale.

1.8 Thesis Organisation

This section discusses the organisation of the thesis layout arrangement. It comprises five main chapters, from Chapter 1 till Chapter 5, respectively.

Chapter 1 presents the overview of the research study, including the background, problem statement, research questions, aim and specific objectives, hypothesis, the scope of research and significance of the research as the initiation of the research. The progress of the research study is being aided by the literature review under Chapter 2 to collect the relevant data from the previous study findings which is necessary and crucial to the research topic. Meanwhile, the research method and research design used in the study are presented in Chapter 3. Chapter 4 outlines the pilot study results, the analysis of data obtained from the field study (actual survey), as well as the discussions on significant findings. Besides, the validation of results for complete acceptance is also presented in this chapter. Lastly, Chapter 5 deliberates the conclusion of the overall research study. Also, there are some recommendations made for future research.

CHAPTER 2

LITERATURE REVIEW

Chapter two presents a comprehensive review of the past research studies which have been done on the DDB analysis. Additionally, this literature review also discusses the methodological considerations used in assessing the different impacts of DDB associated with mobile phone usage.

2.1 Background

Over the past two decades, distracted driving has garnered much attention as one of the major interesting research topics. There is a large volume of published studies concentrated on distracted driving, and that the definition covers a wide range of driving behaviours. Generally, the resulting driving behaviours are associated with the diminished attention to the driving task by different types of distractions which can occur within or outside the vehicle, and as a consequence, a driver will not be able to drive in a safe manner (Regan, Lee & Young, 2008).

While distracted driving involves a shift of attention away from driving, it is, however, different from inattentive driving or commonly known as driver inattention. For instance, research studies done by Regan et al., 2008; Regan, Hallett & Gordon, 2011; Stutts, Reinfurt, Staplin and Rodgman, 2001 identified that distracted driving is one form of inattentive driving. The distinctive characteristics which differentiate both distractions is that the former is initiated by the presence of a competing activity, event object or person (driver diverted attention, DDA). The latter, on the other hand, is a condition in which a driver is distracted by different forms of internalised thought, in terms of driver restricted attention

(DRA), driver misprioritised attention (DMPA), driver neglected attention (DNA) and driver cursory attention (DCA) (Regan et al., 2011).

2.2 Distraction Types

With respect to the sources of distractions, they have been categorised into four specific types, namely visual, auditory, physical (biomechanical) and cognitive distraction (Ranney, Mazzae, Garrott & Goodman, 2000; WHO, 2011).

Visual distraction occurs when a driver's eyes are away from the road ahead in order to interact with other task or looking at a device, e.g., sending or receiving a text. It is found that over a 6-second interval, the high visual demand of texting takes the driver's eyes off the road for 4.6 seconds, averagely or equivalent to driving the length of a football field at 55 miles per hour in a complete blindness condition. Another instance is mobile phone dialing, which is reported to direct the eyes on the mobile phone and off the roadway for 3.8 seconds (Olson, Hanowski, Hickman & Bocanegra, 2009). A driver may appear to look at the road, but in fact, the tendency to have a failure in seeing the road environment increases. This observed phenomenon, according to Ito, Uno, Atsumi and Akamatsu (2001), is known as the loss of visual attentiveness. This potentially elevates the crash risk in unexpected events due to the inability to detect hazards.

Auditory distraction, on the other hand, happens in a driving condition that when the driver responds to ringing mobile phone or focuses on the auditory signals instead of the surrounding road situation, whilst physical distraction is when the driver removes one or both hands off the steering wheel to physically control or operate a device, such as to initiate, answer or end a phone call, which is irrelevant to the primary driving task. Lastly, the cognitive distraction occurs when a driver's attention is withdrawn and he or she is no longer able to process a judgement for safe driving operation. This leads to hazardous driving due to the factors that drivers who are cognitively distracted are found to suffer from slower response time, as well as prolonged reaction time (Strayer et al., 2013). As a result, they fail to detect and respond to critical or abrupt traffic events, even if they do not look away from the roadway, and this situation becomes intensified as the cognitive demands increase (Greenberg et al., 2003).

Despite the classification of the different types of distractions, each can affect the driving impairment of a driver. In fact, it can be in a single distraction or even interact with other forms of distraction into combined distractions. Texting while driving, for example, requires a combination of visual, manual and cognitive attentions from a driver and thus, it is by far the most alarming DDB among all mobile phone activities (National Traffic Law Center, 2017).

2.3 The Prevalence of Distracted Driving Behaviour

Given the proliferation of the use of electronic devices while driving, particularly mobile phones, Pickrell and Li (2017) hold that research into distracted driving has become increasingly prominent. As mobile phone-induced distracted driving is social and rewarding, it remains difficult to tackle (Atchley, Hadlocka & Lane, 2012). Thereafter, this DDB continues to prevail and become an epidemic throughout the world, in which the seriousness has raised safety concerns among the policy-makers.

In 2016, Pickrell and Li (2017) reported that the use of handheld mobile phones while driving during the day constituted for about 481,000 U.S. drivers. Even though the usage has shown a decrement as compared to previous years, the high frequency indicates the habitual DDB which requires further investigations. Besides, the Centers for Disease Control and

Prevention (2013) summarised that almost one-third (31.2%) of all drivers between 18-64 years old in the United States reported to be engaging in mobile phone usage behind the wheel, such as to read, send text messages or email messages. Compared with the aforementioned activities, mobile phone conversation is even more prevalent as it constituted for more than two-thirds (68.7%) of the drivers.

In an earlier study carried out by the Australian Transport Safety Bureau in 2005, the results showed that of the overall 84% of Australian drivers who owned mobile phones, more than half (47%) of the drivers admitted that they have been using mobile phones while driving. Furthermore, it was observed that 43% of drivers admitted to receiving calls, 24% of drivers making calls, 16% of drivers reading, whilst 8% sending text messages while driving (Pennay, 2006).

In Malaysia, Isa et al. (2012) published a paper in which they demonstrated a cross-sectional study on the mobile phone usage behaviour while driving among the college and university students in Klang Valley, Malaysia. The research results explicitly revealed that the majority of the respondents (66.6%) used a mobile phone while driving on urban roads or highway, regardless of initiating or answering phone calls or texting.

2.4 Distracted Driving Behaviour and Crash Contributing Factor

As discussed in the previous section, DDB, particularly distractions associated with mobile phone use while driving was identified as a notable trend today. This behaviour is recognised as one of the risk factors to significantly result in the continuous rising of the rate of distraction-induced crashes every year (Hamilton, Arnold & Tefft, 2013; National Center for Statistics and Analysis, 2017; National Safety Council, 2013).

In another instance, distraction-affected fatal crashes resulted from mobile phone-related activities rose up approximately 14.8% from 385 crashes to 442 crashes between 2014 to 2015. The consequent impact of such distraction can be clearly seen from the number of road casualties which increased by 17.8% (404 to 476 died on the road) within the two-year period. The number of road injuries in the distraction-affected crashes, on the other hand, were estimated at 30,000 in 2015 (National Center for Statistics and Analysis, 2016; 2017).

In fact, numerous research has been concerned about this dangerous driving behaviour and the risk of getting into or causing road crash. For example, Neyens and Boyle (2008) concluded that the tendency of drivers to be involved in severe crashes is much higher when drivers engage in various mobile phone activities and also the distractions caused by passengers than in-vehicle devices, inattentive or even under non-distracted conditions. As more devices are being installed inside the vehicles and as mobile phone usage continues to grow rapidly, the potential for driver distraction and therefore the risk of severe injury from a distraction-related crash is rising, not only among the drivers but also to their passengers in the car.

Klauer, Dingus, Neale, Sudweeks and Ramsey (2006) observed that the naturalistic driving studies such as the 100-car study, provide the most accurate data, where, of the all ages, driver distraction has found to be contributed to 22% of all crashes and near-crash events. Crash risk is the highest when the DDB involve complex visual-manual tasks, require several steps to complete and eye-off-road and lastly do not involve built-in vehicle features (Dingus, Hanowski & Klauer, 2011; Klauer et al., 2006). Overall, the most striking result to emerge from the naturalistic driving studies was that the DDB, which involves complex visual-manual tasks increase the crash or near-crash risk by 600% - 2300% (Dingus et al., 2011).

Based on the in-depth analysis of the usage of mobile phone while driving, it is highlighted that the crash risk was two to four times higher when drivers are on mobile phone conversations (Svenson & Patten, 2005). In addition to the work of Sevenson and Patten, McEvoy et al. (2005) also posited that there was a fourfold increased risk of road traffic crashes which may result in hospital attendance when mobile phones were used while driving. The increased risk of crash involvement was proven through the results, by which the use of hands-free mobile phone increases the crash risk by a factor of 3.8, while handheld mobile phone contributes to a factor of 4.9, indicating that the risk of getting into crashes do not differ significantly whether hands-free or handheld mobile phones are used.

The above findings were consistent with the past research by Redelmeier and Tibshirani (1997), whose study also found that initiating or receiving phone calls while driving was associated with a fourfold increased risk of crashes, and that the risk was discovered to be the greatest for the phone call made within 5 minutes before a crash occurred, by which it recorded a factor of 4.8.

Klauer et al. (2014) revealed that performing secondary tasks, for instance, texting and dialing mobile phones contributed significantly to the increased likelihood of being involved in crashes or near-crashes, particularly among the inexperienced drivers in Southwestern Virginia, United States. Similarly, a related study conducted by the Virginia Tech Transportation Institute (VTTI) to explore the effects of DDB among truck drivers also pointed towards this similar trend, in which the researchers concluded that the risk of a crash, near miss or incident increased with texting, as well as reaching for or dialing mobile phone while driving. However, texting while driving is found to be the most dangerous threat as it contributed to an odds ratio of 23.2, the highest odds ratio among all (Olson et al., 2009). In other words, the crash risk faced by the drivers who text while driving is 23 times higher than that of drivers who do not text while driving. This is because texting while driving results in drivers looking away from the road ahead for prolonged periods of time, and subsequently fail to control their vehicles sufficiently (Owens et al., 2011).

Meanwhile, in Malaysia, statistics by MIROS (2012) indicated that of the 498 road crashes reported from 2007 until 2011, risky driving behaviours contributed to 28% of the total crashes, followed by speeding (21%) and fatigue (15%). Also, other identified factors were safety, health and environment (9%), road defects (8%), driving under influence (5%), brake defects (5%), conspicuousness (4%), overloading (3%) and tyre defects (3%). Although the crash statistics on mobile phone-related road traffic crashes are unavailable yet, the Transport Minister Datuk Seri Liow Tiong Lai confirmed that mobile phone usage while driving is the major risk factor which has contributed to the growing number of road crashes (Ramendran, 2016).

Furthermore, the director-general of the MIROS indicated that distracted driving has resulted in out-of-control driving, which in turn lead to tragic motor vehicle crashes. An evident statistics showed that out-of-control driving made up a total of 1318 of the overall 5672 lethal crashes for the year 2007. On top of that, out of the 27,035 cases, out-of-control driving was identified to account for 3674 (14%) of the total crashes in the same year. Among all distractions, it is believed that the use of mobile phones is the root cause to such phenomenon, in spite of the fact that the law has been enforced to impose restrictions or makes it an offense to use mobile phones while driving (Bedi, 2009).

2.5 Parameters Affecting Distracted Driving Behaviour

2.5.1 Age and Driving Experience

From the past literature, age and driving experience have been found to associate with DDB. Research has consistently found that young drivers are more likely to engage DDB. In the United States, for example, a study examined 403 young drivers aged from 16 to 18 years discovered that 92% of the respondents admitted to regularly commit DDB, with phone call and texting recorded 68% and 48%, respectively (Carter, Bingham, Zakrajsek, Shope & Sayer, 2014).

In a more recent study, Gliklich, Guo and Bergmark (2016), analysed the texting behaviour among 1211 drivers, and their analysis revealed that younger drivers aged less than or equal to 24 years dominated as the most prevalent age group in mobile phone-related DDB. Tractinsky et al. (2013), on the other hand, also discovered that younger and novice drivers below 20 years old tend to underestimate the risks and consequences of interacting with in-vehicle devices, mobile phones in particular. As a result, the tendency of initiating or answering a phone call while driving was higher than that of experienced drivers of 24 to 30 years old (with at least 7 years of driving experience) or older drivers aged over 65, regardless of the road conditions. Older drivers, in contrast, were more vulnerable to the distracting effects under complex road conditions, heavy traffic and winding road in this case.

Additionally, the Australian Associated Motor Insurers Limited (AAMI) (2013) deduced that DDB is dominated by young Austrian drivers. This is because the most striking result to emerge from the data was that the majority (approximately 54%) of young drivers aged between 18 to 24 years more likely to send or read text messages while driving on the road. All these findings matched Poysti, Rajalin and Summala (2005) that younger drivers of 18 to 24 years old were found to facilitate a high proportion of responding to phone calls while driving, in which it was accounted for approximately 20% more than older drivers.

In addition to this over-representation of the involvement in DDB while driving, Poysti et al. (2005) also examined whether or not age is a contributory factor towards the detrimental effects of the DDB associated with mobile phone usage. Of the various potential factors examined, Poysti et al. revealed that younger drivers engaged in mobile phone usage while driving were eight times more likely to be involved in crash risk than that of older drives. This is supported by the World Health Organization (WHO), as it has been highlighted that young driver of 15-19 years of age representing the highest proportion of DDB crashes. Besides, a personal interview survey conducted in Texas also showed that novice drivers were more likely to be involved in mobile phone-related crashes than that of experienced drivers (Sun & Jia, 2016).

Undoubtedly, as compared with older, experienced drivers, young novice drivers have less driving experience and inadequate good driving skills which are very crucial in operating and maneuvre their vehicles with minimal attentional resources. Consequently, the novice drivers do not have sufficient spare attentional capacity to devote to secondary non-driving tasks (Young & Regan, 2007). When this happens, the impacts on the crash risk are significant as it results in a dramatic degradation in driving performance among them.

It is also crucial to note that, DDB associated with mobile phone usage does not only affect young and novice drivers, but could as well have implications for middle-aged and older drivers. According to Strayer and Drew (2004), the impacts of mobile phone conversations while driving were equivalent to both young drivers (18-25 years old) and old drivers (65-74 years old), while a study conducted by Thompson et al. (2012) to examine

DDB among elderly and middle-aged drivers showed that both the older (30%) and middle-aged (43%) drivers performed driving errors when they were being distracted while driving.

Prior to that, Li, Gkritza and Albrecht (2014) found that although younger drivers were more likely to be involved in mobile phone-related DDB, but in terms of the distractibility, older drivers have been reported more than younger drivers counterpart. More recently, by using a driving simulator, Papantoniou (2015) discovered that of 95 drivers tested, the findings also indicated that older drivers were significantly more likely to perform driving errors, as compared with young and middle-aged drivers.

Although previous findings have shown that there are greater performance decrements among older drivers as compared to younger drivers, the former, however, would self-regulate so as to reduce the impacts of DDB. For instance, reducing the speed of the vehicle or avoid using mobile phone while driving (Young & Regan, 2007). Despite prior evidence, it was later shown by Precht, Keinath and Krems (2017) in their study that, age and driving experience did not significantly affect driving errors and traffic violations. Thus, the effect of age and driving experience should be looked into detailed in the current study.

While the degree of DDB among young drivers has not been compressively researched in Malaysia, MIROS (2012) revealed that the distribution trend of road fatalities over the past ten years has been predominantly contributed by the age group of 16 to 25 years old.

2.5.2 Gender

Regarding gender, Goodwin, Foss, Harrell and O'Brien (2012) concluded that younger female drivers were twice more likely to engage in electronic device use than the male counterpart. This is, however, contradict with the studies (e.g., Isa et al., 2012; Li et al., 2014; Tucker, Pek, Morrish & Ruf, 2015), which found that the involvement in DDB on urban road among young male drivers were greater as compared to female drivers. Interestingly, Eastman (2013) and Carter et al. (2014) failed to find any gender-related differences in the involvement of DDB among the adolescent drivers, as well as drivers from other age groups Gliklich et al. (2016) .

Researchers studied the differences in the profound effects of DDB among male and female drivers, and they summarised that the latter were relatively susceptible to the distractions as compared to the former (Hancock et al., 2003; Lesch and Hancock, 2004). In another study, gender effect only appeared on the self-reported mobile phone usage, but did not yield any significant difference on the hazards experienced (Poysti et al., 2005). However, the resulting impacts of DDB on female drivers was in direct agreement with the study by Neyens and Boyle (2008), which posited that there was a significant difference in the injury severity between male and female drivers. In their comprehensive study on the impact of DDB on the corresponding severity of injuries of teen drivers and passengers, they have highlighted that female teenage drivers have an increased likelihood to be severely injured than that of their male counterparts.

In line with the researchers' idea was Papantoniou (2015), whose study demonstrated that female drivers suffered a greater proportionate disadvantage in relation of their own error. Furthermore, a more recent study by Sun and Jia (2016) also pointed towards this similar trend on the threats experienced, but no significant difference was found between mobile phone usage and the involvement in traffic incidents. Therefore, it is crucial to explore whether or not gender, is a significant factor in affecting DDB associated with mobile phone usage in this study, not only among adolescent drivers, but middle-aged and old drivers.

2.5.3 Occupation

Interestingly, Poysti et al. (2005) explicitly revealed that the occupation was significantly correlated to phone-related hazards, other than age and amount of mobile phone usage while driving a day. As compared to retirees, the results indicated that drivers in the leading positions in a company were three times more likely to be involved in hazardous situations.

2.5.4 Frequency of Usage

Given that drivers realize the substantial risks of mobile phone usage while driving, the tendency to engaging in such behaviour does not seem to reduce, and this has proven by Nelson, Atchley and Little (2009) in relation to initiate or answer a phone call, as well as in the study of Atchley, Atwood and Boulton (2011) on the texting behaviour.

As highlighted by Hamilton, Arnold and Tefft (2013), the increasing use of mobile phone while driving is associated with a higher frequency of engaging in various reckless driving behaviours such as driving over the speed limit on a freeway and running a red light. Subsequently, the drivers reported a greater risk of crash involvement. In fact, the finding was consistent with the study by Harrison (2011). Harrison investigated the dangerous behaviour of texting among the young college students using self-reported study and concluded that texting behind the wheel was pervasive among them, with almost all of the students (91.2%) admitted to have engaged in such DDB. Also, he found evidence of the violations committed and hazards experienced due to the greater frequency of texting while driving.

More recently, the research study by Sun and Jia (2016) on the examination of the impacts simultaneous mobile phone usage and driving also showed similar results. The drivers reported a higher likelihood of experiencing hazards, such as sudden evasive maneuver and fail to stop at a signal or stop sign, if they were to use a mobile phone frequently.

2.5.5 Traffic Conditions

Traffic condition is another factor closely linked to the study of DDB. For example, Atchley et al. (2011) summarised from the findings that the likelihood of drivers to text while stopping at a traffic light or stop sign ranged from very to extremely likely. In contrast, they were less likely to engage in such DDB when driving under severe condition. On the other hand, the effect that would occur if drivers converse in mobile phone in low or high traffic was also monitored by Papantoniou (2015). The simulator results provided a valid indication that drivers had a significantly greater likelihood to be involved in unexpected incidents in low traffic condition, particularly due to the lower concentration and higher speed as compared to when driving under high traffic condition.

2.6 Distracted Driving Behaviour and Driving Error

DDB is a complex, multidimensional phenomenon. Although a numerical study has been investigated on the concept of DDB, however, it was later shown by Regan et al. (2011) that there is still much to understand about DDB and its relationship with other aspects of human cognition and behaviour. Moreover, Young and Salmon (2012) mentioned that there is a lack of evidence of the significant relationship between DDB and driving error.

In fact, driving error has long been identified as an important focus of road safety research (Young, Salmon & Cornelissen, 2013), and that the knowledge can be used to build upon its role in the crash and incident causation. The estimates by researchers in the past suggested that driving error is a causal factor in 45% to 75% (Hankey et al. as cited in Wierwille et al., 2002), and even up to 95% (Rumar, 1990) of road traffic crashes. For example, Staubach (2009) confirmed the contribution of distraction on drivers committing errors through a detailed examination of 474 crashes. Staubach found significant evidence that a number of lane departure crash (41%), same direction crash (38%), as well as crossroad crash (32%) were associated with the nature of errors made by the distracted drivers while driving on the road.

Another study conducted by Sandin (2009), which aimed to identify the most frequent errors and violations underlying the urban intersection crashes, for instance, a failure to yield, or running a traffic light or sign. The results of the study revealed that distractions contributed to a range of errors, including missing a sign or traffic signal, misjudging the timing of amber light, and a failure to see other vehicles, in which these have resulted in devastating road crashes occurring at intersections. Likewise, distractions by in-vehicle devices or tasks have shown to contribute to errors such as lane excursions, speed violations (passing on the red, failing to advance on the green) and stop light violations (Horrey & Lesch, 2009).

Based upon the driving error taxonomy, the nature of errors made by drivers, regardless of whether or not they are being distracted, have also been highlighted by Young et al. (2013). Of the different types of driving errors, exceeding speed limit, lane excursions, activate indicators too early before a turn, followed by travelling too fast for turn were found to be the most prevailing errors committed by the drivers. In terms of the mechanism underlying the specific error types, it included violation, cognitive errors, action errors, as well as observation errors. Despite prior evidence, the surprising observation to emerge from the results is that every driver committed errors on each drive, but the likelihood of errors made when distracted was much higher as compared to when they were not distracted. In short, the study concluded that distraction-induced errors are not varying across types, but the degree to which these distractions can lead to driving errors.

In relation to the usage of mobile phone, vast majority of research has also demonstrated the disruptive effects of phone call and texting while driving. In other words, the drivers were poorly calibrated to the effects of distraction when they try to perform dual-tasks synchronously. One of the most common errors which arise while engaging mobile phone while driving is the increased in reaction time. This is identified by McKnight and McKnight (1993), which concluded that the likelihood of the drivers to respond to important surrounding traffic events, such as vehicles ahead slowing down or fail to see pedestrians entering the road, decreased when they were in different mobile phone conditions. These include, initiating a phone call, engaging in simple conversation and complex conversation, and that the impairment was found to be the most pronounced when drivers deal with complicated conversations over the mobile phones.

Strayer et al. (2003) examined the conversations on hands-free mobile phone using driving simulator. Interestingly, the results also revealed a significantly increased in reaction time and slowed response towards the lead braking vehicle. Furthermore, Strayer et al. mentioned that such error was more conspicuous as traffic density increased. As such, the drivers tend to brake intensely in order to compensate for the decreased brake response time, so as to avoid a crash with the vehicle in front. Additionally, a study found that driver tends to drift out of the lane (Tractinsky et al., 2013), and that the errors found have no difference between conversing in either hands-free or handheld mobile phone (Horrey et al., 2008).

Texting while driving, on the other hand, has also been documented to cause drivers to commit driving errors. Using a driving simulator, Hosking et al. (2009) found evidence that retrieving and sending text messages while driving among the novice drivers led to as much as 28% more of lane excursions and the variation in lane position was shown to increase by up to 50%. Additionally, Hosking et al. observed that drivers missed lane changes frequently and increased the variability of distance with the lead vehicle.

Similarly, Harrison (2011) explored the behaviour of texting while driving of 91 college students. On the basis of the results, it has been identified that drivers committed a significantly higher number of lane excursions. The dangers of texting while driving can also be accounted for exceeding the speed limit and a failure to heed a stop sign.

More recently, using meta-analysis in analysing 28 different studies, Caird, Johnston, Willness, Asbridge and Steel (2014) concluded that incapability of direct attention to the roadway, stimulus detection (failure to respond to important traffic events), slower reaction time, increasing in the likelihood of involving in collisions, lane positioning, inability to maintain speed and headway were highly associated to the devastating aftereffects of typing and reading text messages simultaneously while driving. This can be explained by the research findings of Ranney (2008), which pointed that the response time of distracted drivers decreased to 130 milliseconds, averagely, if they were to engage in mobile phone use while driving.

Based on the in-depth analysis of the previous research, regardless of the types of mobile phone usage, both phone call and texting have been found to tax approximately the same error type. Impairment in the ability to make safe decision making has also been found in studies examining mobile phone distractions while driving (Cooper & Zheng, 2002; Cooper et al., 2003). Cooper and Zheng (2002) exposed 39 drivers to approximately 100 gaps between 8 vehicles circled the test circuit, while they had to listen and respond to a complex message for the first half of the trials (wet road surface) versus other half of the trials without distraction (dry road surface). A conclusion has reached that complex in-vehicle phone task led to a risky decision making in turning left through gaps, and they did not take into account the road surface condition.

Cooper et al. (2003), on the other hand, exposed 41 drivers to three different driving conditions. Similarly, the drivers were required to listen and respond to complex messages while performing the driving task, and the results also revealed the unsafe decision making in complex driving situations such as weaving and whether or not to accept or reject a gap when turning left into the on-coming traffic.

Another study conducted by Hancock et al. (2003) exposed the drivers on a test track to confirm the in-vehicle mobile phone-based distraction. The results showed that the distracted drivers tend to perform intense braking when they have to stop at a traffic light. In other words, they are more likely to brake late, but compensate for this late braking by braking harder. Although it was found that drivers tend to reduce their driving speed and increase the headway distance with the leading vehicle in order to compensate for the decreased attention when mobile phones were used simultaneously while driving, nonetheless the cognitive demands and longer eyes-off-road times have deleterious effects on safety and consequently increase the crash risks. This compensatory behaviour has also been found in a slew of studies such as Young and Regan (2007).

Generally, from the past research findings, the results clearly indicate that DDB contributes to a range of driving errors and performance measures. With regard to the relationship between DDB and different error types, it is obvious that Young et al. (2013) has demonstrated the errors committed by drivers, in terms of road violations, cognitive errors, action errors and observation errors. This has become an interesting topic central to DDB and hence, the research based its main framework on the one developed by Young et al. (2013). However, this research focused on the technology-based DDB, mobile phone in this case.

The studies were conducted overseas and was found lacking exploration in Malaysia. As such, it would be both beneficial and interesting to look into the likelihood of driving errors due to DDB associated with mobile phone usage in Malaysia. The further quantification of the present research study is of utmost importance which allows a thorough understanding on how phone call and texting actually fare in various driving errors.

2.7 Methodological Approach in Assessing Distracted Driving Behaviour

As aforementioned, there have been a number of published studies in scientific journals and conferences which employed vast techniques in the analyses of driving errors due to DDB. These methods include, surveys, driving simulator, on-road study, naturalistic driving and crash-based study, and each approach is discussed in the following sub-sections.

2.7.1 Surveys

According to Papantoniou (2015), a questionnaire is developed in the stated behaviour surveys, and assessed in a sample of the population of interest. A range of methods can be used to collect the data from the representative sample, such as personal (face-to-face) interviews, telephone interviews and postal questionnaires. An example of this method is the Driver Behaviour Questionnaire (DBQ) which has been developed in the 1990s. DBQ is a self-reported behaviour assessing tool whereby the respondents have to respond to each behavioural item, by indicating how frequently they behave under each behaviour while driving, based on a 6-point scale (Reason, Manstead, Stradling, Baxter & Campbell, 1990).

In fact, one of the biggest advantages of using questionnaires as a tool for research is that the items in the questionnaire are based on the real-world observations, whereby the investigations into new trends or situations of that population can be carried out. Likewise, it is cost-effective and time-saving as the data can be collected in a short period of time (Salkind, 2012).

Other researchers in the past (e.g., Atchley et al., 2011; Atchley et al., 2012; Carter et al., 2014; Eastman, 2013; Gliklich et al., 2016; Harrison, 2011; Isa et al., 2011; Li et al., 2014; Poysti et al., 2005; Staubach, 2009; Sun & Jia, 2016; Tucker et al., 2015) have also employed such methodology in measuring the DDB associated with mobile phone usage.

2.7.2 Driving Simulator

Other than utilizing a survey questionnaire, driving simulator is also widely used to study the impacts of DDB associated with mobile phone usage while driving (e.g., Greenberg et al., 2003; Hosking et al. 2009; McKnight & McKnight, 1993; Papantoniou, 2015; Strayer & Drew, 2004; Strayer et al., 2003; Tractinsky et al., 2013). Driving simulator is a type of relatively realistic simulation study in which the driving tasks of a driver can be monitored by the experimenter.

By using this technique, a range of driving performance measures can be examined in a controlled, safe driving environment. This is because the type and difficulty of driving tasks (e.g., risky driving situations) are allowed to be precisely specified. Moreover, the potentially confounding variables (e.g., day or night, weather conditions or road environment condition) can be eliminated or controlled for, with relative ease. All these are difficult or dangerous to be generated under real-driving conditions (Papantoniou, 2015).

2.7.3 On-Road Study

On-road study provides a real-time recording of driver while driving, and several studies have attempted on this methodological approach for collecting data on DDB (e.g., Cooper & Zheng, 2002; Cooper et al., 2003; Hancock et al., 2003; Horrey & Lesch, 2009; Horrey et al., 2008; Lesch & Hancock, 2004; Thompson et al., 2012; Young et al., 2013). It involves an instrumented test vehicle equipped with instrumentation to record two main types of data, namely, vehicle-related and eye-tracking data. Vehicle-related data are obtained from the vehicle network, consisting of vehicle speed, GPS, accelerator and brake position, steering wheel angle, lane tracking and headway logging, primary controls (windscreen wipers, indicators) and secondary control (sat-nav, entertainment system). Eye-tracking data, on the other hand, is tracked via driver's-eye camera view (Young et al., 2013).

Ball and Ackerman (2011) presented a comprehensive review of on-road study, and they reported that it is used to test driver competency as drivers perform their daily driving tasks, which also includes aspects of driving that may not be easily replicated by other methods. Moreover, it has been found to be used as the measurement standard in evaluating driving simulation studies and validating the off-road assessment of driving ability.

2.7.4 Naturalistic Driving Study

Regan, Williamson, Grzebieta and Tao (2012) highlighted that the Naturalistic Driving Study (NDS) is a relatively new research method, pioneered by the Virginia Tech Transportation Institute (VTTI) in the United States. By utilizing an NDS, instruments are installed in participants' vehicles in order to record and observe their daily driving behaviour, in terms of eye, head and hand manoeuvres, over a period of time. Other than the driver behaviour, vehicle manoeuvres (speed, acceleration/deceleration, direction) and external conditions (road and traffic condition, weather will also be unobtrusively recorded).

As compared to the conventional research methods, NDS provides a way to yield a more detailed real-world driving data to better understand the relationship between driver, road, vehicle, weather and traffic conditions in normal driving conditions (SWOV Institute for Road Safety Research, 2012). It also offers a much wider perspective in understanding the critical differences between near-crash and crash (Regan et al., 2012). Therefore, it can be found that numerous studies have used this method in providing crucial insight into DDB and the occurrence of a crash or near crash (e.g., Dingus et al., 2006; Goodwin et al., 2012; Klauer et al., 2006; Klauer et al., 2014; Olson et al., 2009).

2.7.5 Crash-Based Study

Crash-based study is the collection of data from the police-reported crash reports (Neyens & Boyle, 2008) or case files (Sandin, 2009; Stutts et al., 2001).

The case files, on the other hand, are derived from the in-depth investigation by the crash investigation teams, which consist of trained professional from multiple disciplines, independent of the police. They collect as much information at the crash scene, from an examination of the crash-involved vehicles, directly interview with the crash victims and witnesses, as well as from the available medical records.

2.8 Analysis Methods

As far as methods employed to analyse driving errors due to DDB are concerned, there have been several approaches developed for modeling the likelihood of driving errors. The most common technique is by using multivariate analysis such as regression methods.

For example, Sun and Jia (2016) used logistic regression to investigate the potential factors in contributing to the likelihood of phone-related hazards or crashes. Papantoniou (2015), on the other hand, made an in-depth study of distracted driving on the risk factors, driver behavior and accident probability using Structural Equation Modelling (SEM). On the basis of the results, Papantoniou found that young or old female drivers are more likely to commit driving errors in urban areas. Besides, he also pointed that the likelihood of female drivers to be involved in an incident increases when they are talking on the mobile phone while driving in low traffic conditions.

2.9 Summary

Thus, based upon the detailed and comprehensive literature as reviewed above, this research study has the tremendous potential to provide a good insight on how and to what extent engaging in the different types of distractions while driving will induce different categories of driving errors. For the methodological approach, since the present study seeks to identify the distractions associated with mobile phone use while driving on the underlying driving errors which cannot be measured directly. Hence, it appears that one of the best method to obtain the data is by evaluating the drivers' driving behaviours through survey questionnaires in order to better understand the DDB theoretical model. It is to be used together with advanced statistical software, IBM SPSS Statistics 21.

The fact that DDB intensity is capable of reducing driving proficiency has been well documented in literature. It should be noted from the above literature review, most attention has been paid to conduct the distracting effects of mobile phone use while driving on driving performance impairments. Unfortunately, to the best of author knowledge, less attempt was made by the researchers in the past to investigate how different types of distracted driving associated with mobile phone use while driving will impact different category of driving errors. Besides, far too little attention has been paid to do this deep research on the DDB in Malaysia and hence, this has motivated the present study.

With the in-depth examinations of the DDB among the drivers, it would allow a comprehensive and better identification of the related risk factors of DDB associated with mobile phone usage. Despite the fact that there is no record found regarding the mobile phone-related road crashes, it is believed that such activity has a significant impact on the occurrence of road crashes in Malaysia due to the fact that the number of mobile phone ownership and usage has increased over the past years. In addition to the recognition of risk factors, the long term implication of this study is that the positive outcomes of this research are very crucial in drawing up the effective safety measures and then focusing on the implementation of the improvements of the road traffic safety in Malaysia.

In sum, combined efforts, for example, legislation, enforcement, blocking technologies, parents modelling, social norms as well as education will be required to reduce and prevent the continued fatalities and injuries from mobile phone distraction while driving.

CHAPTER 3

RESEARCH METHODOLOGY

Chapter three outlines the range of research methods used for data collection, data analysis and interpretation throughout the research study. Choosing and applying appropriate research methods in this stage are crucial in answering the research questions pertaining to the research problems and thus help to achieve the aim and objectives of the research study.

3.1 Background

A sequential research method was designed to clarify the identified research questions, as well as to test for the designed research hypotheses. In the present study, the DDB, specifically, the use of mobile phone while driving on drivers' driving errors was examined, and was guided by the three research questions (RQ's) which have been discussed in the first chapter. These include:

RQ1. What is the pattern of DDB associated with mobile phone usage in Malaysia?

RQ2. How different types of DDB (phone call and texting) influencing different categories of driving errors (road violations, cognitive errors and action errors)?

RQ3. What are the significant DDB variables (age, gender, occupation, driving experience, frequency of usage and traffic conditions) associated with mobile phone usage in predicting the likelihood of driving errors (road violations, cognitive errors and action errors)?

The preliminary data analysis, as well as the logistic regression at the later stage was performed using prominent statistical software, IBM SPSS Statistics 21, so that the research questions and research hypotheses that have been developed in the early stages could be answered. The flow of the research methodology for this research study is visible in Figure 3.1. It summed up the overall process on how the research was carried out throughout the whole study period.

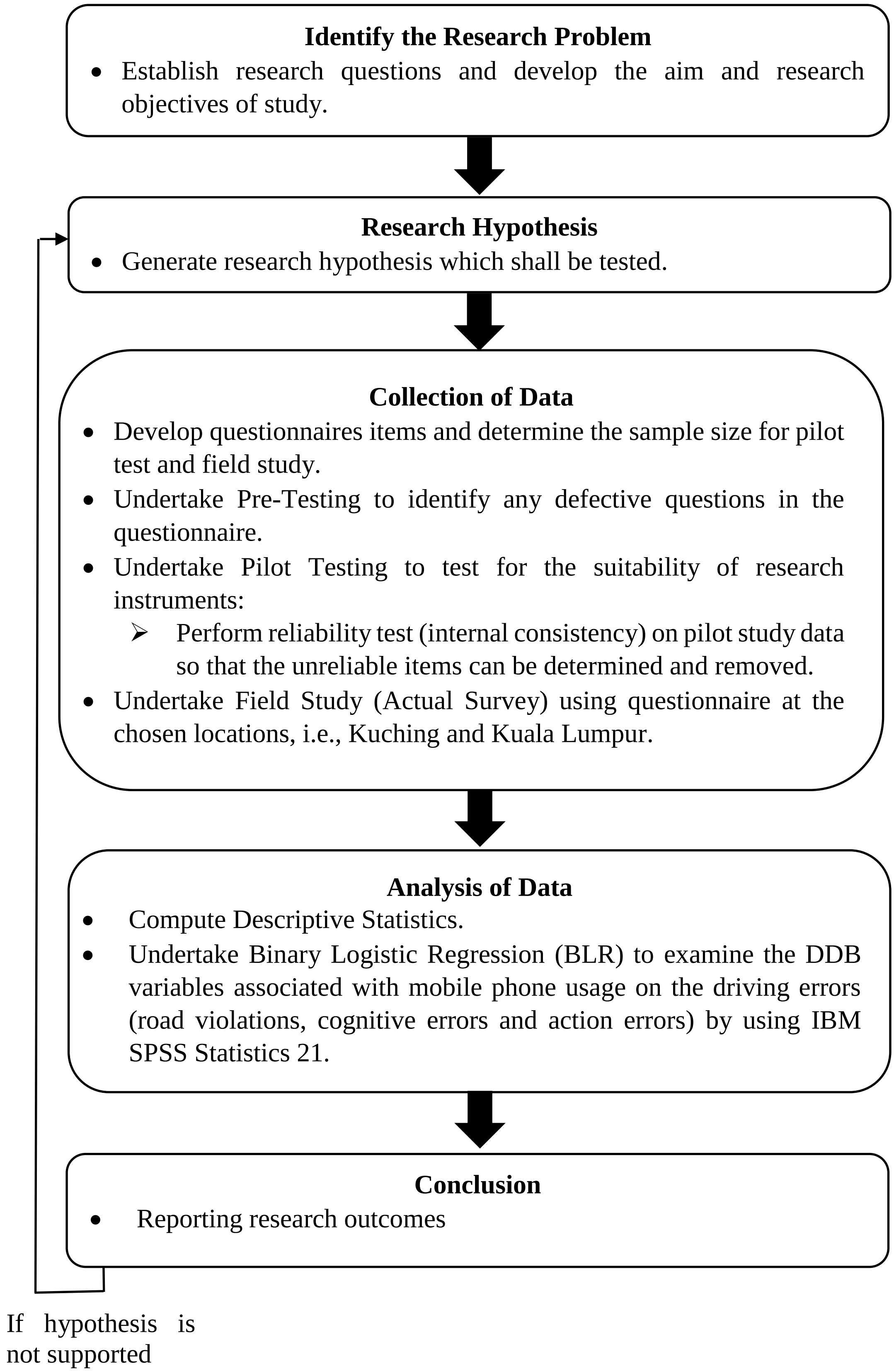

Figure 3.1: The Flow of Research Methodology

3.2 Data Collection

3.2.1 Quantitative Research

According to Creswell (2014), quantitative research is a method in which the objective of a research will be tested by determining the relationships between two or more variables, using quantitative analysis techniques. Furthermore, it is especially useful in exploring the theory of the research. In qualitative research, however, non-numerical (qualitative) primary data are collected as the cause-and-effect relationship among the variables is not the focus in such research (Salkind, 2012).

In Chapter 2, it was found from the past related research that quantitative approach have been widely used in examining the tragic impacts of DDB. Thus, in responding to the underlying causal relationships of the DDB associated with mobile phone usage and driving errors, which in accordance to Creswell (2014), quantitative method is thus the most appropriate approach to be utilized in the present study.

3.2.2 Population

Salkind (2012) defined population as "a group of potential participants to whom you want to generalize the results of a study". When the results of a study are generalizable, it means that the outcomes can be repeated to a different representation of the population of interest with the same characteristics in different settings, but still yield the same results. In other words, it is about how the study can be applied in another context. The importance to have generalizability of the results is that the research findings can benefit the diverse scientific community.

As described earlier in the previous chapter, Malaysia has long been reported to have contributed to a high number of road crashes worldwide, and that MIROS believed that the distractions resulted from the usage of mobile phone while driving is the root cause of road traffic incidents (Bedi, 2009). Although the government has imposed a legislative ban on the use of mobile phone while driving on the road (under Section 17A (1) of Road Transport Act), the number of reported cases is still steadily increasing over the years. Therefore, the target population for this research was among the drivers (whom have been involved in DDB associated with mobile phone usage) of urban neighbourhoods in Malaysia, focused in Kuching (the representative sample of East Malaysia) and Kuala Lumpur (the representative sample of Peninsular Malaysia). The underlying reason and consideration for selecting these two regions as the desired locations for data collection was because the researcher is interested in investigating the culture of mobile phone-related distracted driving, so as to enhance the traffic safety of the whole country. Another reason was due to the need of the presence of the researcher when the survey questionnaires were distributed out to the respondents. In that regard, the rate of response and the accuracy of the data could be increased, which then produced a high quality of data.

3.2.3 Sampling

Sampling, on the other hand, refers to the procedure of drawing a sample from the population of interest (Scheaffer, Mendenhall, Ott & Gerow, 2011). There are two types of sampling techniques in the survey research, namely the probability sampling and non-probability sampling. Probability sampling is a method in which the sample is randomly selected from the sample frame of the target population (Scheaffer et al., 2011), and that the probability of being selected from the population is known (Salkind, 2012). In other words, the individual element in the target population has a known and equal chance of being drawn as part of the sample. On the contrary, the likelihood of selecting the element is not known when the non-probability sampling is performed.

Hence, after taking a final count, it is obvious that the probability sampling was the most appropriate sampling method in determining the overall population of interest (drivers within the operational zones of Kuching and Kuala Lumpur) for this research, and simple random sampling was chosen to be employed for selecting the appropriate respondents during the data collection process. With simple random sampling, a high degree of representativeness of the sample was ensured because every driver had an equal and independent chance of being selected as a respondent to participate in the survey. This is also in line with Salkind (2012), who concluded that biases could be reduced when sampling randomly, and that the results obtained are generalizable towards the whole population.

In short, choosing and computing the correct method of sampling is deemed to be critically important in this research because better sampling leads to an accurate representation of the population with the similar characteristics and thus, minimizing the sampling errors.

3.2.4 Sample Size Determination

3.2.4.1 Pilot Test

In a pilot test, the recommended sample size would be one-tenth of the actual survey sample size (Meyer & Booker, 2001). Equally interesting is this study also reflected the findings of earlier literature (e.g., Lackey & Wingate, 1986).

Hence, in keeping abreast with the previously conducted studies, it was decided that a sample of 77 was used as the final sample size for the pilot study. They represent 10% of the sample size calculated for the actual survey (refer to Section 3.2.4.2). This is also parallel with the suggestion by Ruel, Wagner and Gillespie (2015), which cited a general rule of thumb of 30 to 100 subjects for pilot testing. By doing so, the accuracy of the reliability test could be maximized, and contributed to the success of the current research project as a whole. Eventually, 77 questionnaires were distributed to the respondents in the Kuching City at this stage.

3.2.4.2 Field Study (Actual Survey)

The next stage after which the pilot test has been conducted was an actual survey involving a total of 770 respondents. The sample size of 770 was determined based on the Cochran's Equation (Israel, 1992) as listed in Equation 3.1 below:

$$n_0 = \frac{Z^2pq}{e^2} \qquad (3.1)$$

Where;

n_0 = sample size

Z^2 = Abscissa of normal curve that cuts off an area, α at the tails

(1 - α equals the confidence level)

e = Desired level of precision

p = estimated proportion

q = 1-p

For the current study, it is assumed that 5% of the sample size would be the unrepresentative samples. Hence, a confidence level of 95% was used. Besides, it is reckoned that ±5% precision level (also known as sampling error) would be the most appropriate level (Israel, 1992). To compute the Z-score, first, divide 1-α by 2 (= 0.475). From Figure 3.2, it can be seen that the area corresponded to the left of the required Z-score is 0.475 + 0.475+ 0.025 = 0.975. Hence, the critical value of Z obtained from the standard normal curve areas table is shown to be 1.96 (refer to Appendix A).

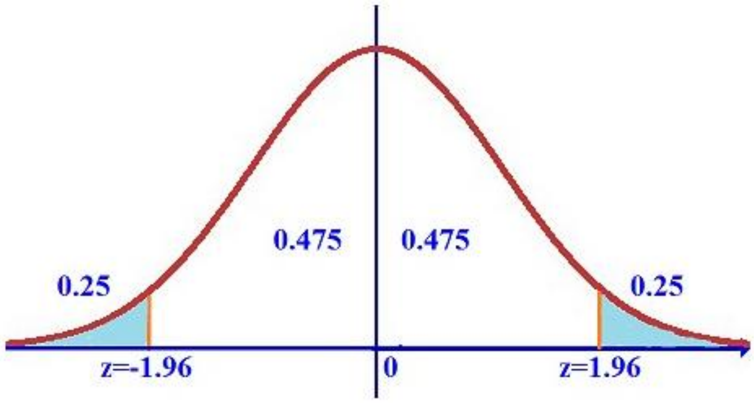

Figure 3.2: Standard Normal Curve (Math Captain, 2015)

Meanwhile, the percentage responding to the questionnaire was assumed p = 0.5 (maximum variability in a population). Using the above formula, the total number of samples required for the actual survey is:

$$n_0 = \frac{Z^2pq}{e^2}$$

$$= \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2}$$

= 385 x 2 (two different locations, i.e., Kuching and Kuala Lumpur)

= 770 respondents

Since the collection of data would be conducted in the two cities in Malaysia, it is sensible that a sample of 385 was undertaken in the actual survey for each city, respectively. This is not only in line with the sample size requirement, but to ensure the adequacy for running the regression. According to Long (1997), the minimum sample size that is required for logistic regression is 100 and the ideal sample size is 500 in which the minimum cell score for each predictor is 10 cases. In short, a sufficient amount of sample size would reduce bias and that more accurate results can be achieved.

3.2.5 Self-Administered Questionnaire

This research focused on the behavioural study of mobile phone usage while driving on a daily basis. For this reason, the best approach to understand the mobile phone behaviours among the drivers was by means of face-to-face approaches and self-administered questionnaire, in order to generate a more comprehensive information from the respondents. As discussed by Scheaffer et al. (2011), self-administered questionnaire is one of the effective data collection techniques in which the respondents are required to complete the questionnaire on their own. Previous research studies (Atchley et al., 2011; Atchley et al., 2012; Eastman, 2013; Gliklich et al., 2016; Harrison, 2011; Isa et al., 2011; Tucker et al., 2015) have also used the self-administered questionnaire to account for the aberrant driving behaviours of drivers.

Although the theory behind this method is without the involvement of an interviewer, however, to ensure a higher response rate in this study, the researcher assisted the respondents personally in completing the questionnaire by clarifying the meaning of each question during the data collection process. This is in fact crucial in contemplation of reducing the incomplete or missed questions as any uncertainties or potential queries on the questionnaire can be resolved instantaneously with the presence of the researcher.

3.2.6 Questionnaire Design

The questionnaire (refer to Appendix B) consisted of three sections, which include the following:

Section I: Respondents’ basic demographic information

Section II: DDB associated with mobile phone usage

Section III: Impacts of DDB associated with mobile phone usage on driving errors

In Section I, the questions sought to provide the demographic background of the respondents, in terms of age, gender, ethnicity, occupation and their driving experience.

In Section II, the respondents were instructed to provide in-depth information on their mobile phone behaviours while driving. The information provided was in fact crucial in understanding the patterns of drivers undertaking different types of DDB associated with mobile phone usage. Similarly, the items used to develop the questions have undergone rigorous review of past literature, and modified based on the current DDB situations in Malaysia so as to fit the context of the study.

In Section III, the various underlying driving errors committed by the drivers under phone call and texting while driving were assessed, the three main categories of distraction-induced driving error constructs, i.e., road violations, cognitive errors and action errors were identified and classified in Young et al.’s (2013) study. The development of the driving error constructs is illustrated in Table 3.1 below:

Table 3.1: Development of Driving Error Constructs

Constructs	Source(s)
Road Violations (RV) Cognitive Errors (CE) Action Errors (AE)	Young et al. (2013)

Apart from the construction of the driving error constructs, the different items in each of the construct were also pinpointed from the said study and compared to the findings of a number of past research studies (Caird et al., 2014; Cooper & Zheng, 2002; Cooper et al., 2003; Hancock et al., 2003; Harrison, 2011; Horrey & Lesch, 2009; Horrey et al., 2008; Hosking et al., 2009; McKnight & McKnight, 1993; Sandin, 2009; Strayer et al., 2003; Tractinsky et al., 2013; see Table 3.2.

Table 3.2: Development of Items Pertaining to Driving Error Constructs

Items	Source(s)
1. Exceed speed limit	Harrison (2011) Horrey & Lesch (2009) Horrey et al. (2008) Young et al. (2013)
2. Red light running	Hancock et al. (2003) Horrey & Lesch (2009) Horrey et al. (2008) Sandin (2009)
3. Misjudge gap when turning	Cooper & Zheng (2002) Cooper et al. (2003) Young et al. (2013)
4. Travelling too fast for turn	Young et al. (2013)
5. Fail to see pedestrian on crossing	McKnight & McKnight (1993) Young et al. (2013)

Table 3.2 continued

Items	Source(s)
6. Lane excursions	Caird et al. (2014) Harrison (2011) Horrey & Lesch (2009) Horrey et al. (2008) Hosking et al. (2009) Tractinsky et al. (2013) Young et al. (2013)
7. Brake late and hard	Hancock et al. (2003) Horrey et al. (2008) Strayer et al. (2003) Young et al. (2013)
8. Leave indicator on after turning complete	Young et al. (2013)
9. Assume an action is legal when not	Young et al. (2013)
10. Accelerate too fast	Young et al. (2013)
11. Indicate too early before a turn	Young et al. (2013)
12. Fail to indicate when turning	Young et al. (2013)
13. Press accelerator when trying to brake	Young et al. (2013)
14. Following too close with leading vehicle	Young et al. (2013)

The error types were specified, adapted and finally developed to become the core framework in this DDB associated with the mobile phone usage study. The different driving errors that one driver may make were measured by a slew of different items and relate to each type of mobile phone activity while driving, in this case, ‘making or receiving phone call’ and ‘texting’.

Hence, there was a total of 14 items, each measuring one of the three driving error constructs, for example, road violations (with two indicators), cognitive errors (with seven indicators) and action errors (with five indicators); visible in Table 3.3. The options were made consistent across the items to ensure the achievement of a reliable and valid data, and hence increased the accuracy and precision of the research instruments.

Table 3.3: Overall Research Instruments of DDB Associated with Mobile Phone Usage

Constructs	Items	Scale
Road Violations (RV)	1. Exceed speed limit	1-10
	2. Red light running	
Cognitive Errors (CE)	3. Misjudge gap when turning	1-10
	4. Travelling too fast for turn	
	5. Fail to see pedestrian on crossing	
	6. Lane excursions	
	7. Brake late and hard	
	8. Leave indicator on after turning complete	
	9. Assume an action is legal when not	
Cognitive Errors (CE)	10. Accelerate too fast	1-10
	11. Indicate too early before a turn	
	12. Fail to indicate when turning	
	13. Press accelerator when trying to brake	
	14. Following too close with leading vehicle	

3.2.7 Likert Scale Questionnaire

Likert scale has been widely utilised in the vast majority of quantitative research studies. A Likert scale is a psychometric response scale with multiple categories to gauge the respondents' level of agreement based on the item statement or set of item statements in the questionnaire (Dane, 2006; Nemoto & Beglar, 2014). In addition to the determination of the level of agreement, Likert scale acts as an effective approach in measuring the perspective, attitudes or feelings of respondents on certain issues (Nemoto & Beglar, 2014).

In the current research, the questions were presented in a 10-point Likert scale, and the respondents were asked to indicate how likely they would commit the errors under each of the item statement in the determination of different mobile phone behaviours while driving. The reason why the questions were designed in an interval scale from 1 to 10 is because a 10-point Likert scale question is more effective than that of a question designed in 5-point Likert scale. A survey research, but in another field of study, compared the difference between the two scales and concluded that the former is able to capture a large amount of data, as compared to the latter (Coelho and Esteves, 2007).

Moreover, the 10-point Likert scale without label gives more freedom of choice to the respondents, where the forced measure would not occur. In contrast, the 5-point Likert scale with label would produce ordinal data instead of interval data, and therefore do not meet the assumptions for employing parametric analysis (Zainudin, 2012). These assumptions, according to the Zainudin, are in terms of:

- Independent (scale employed must be continuous)
- Identical (population of interest must be homogeneous)
- Normally distributed (random selection of respondents using suitable method of probability sampling).

3.2.8 Procedure

The first stage after the development of the questionnaire is the pre-test process. The purpose of conducting a pre-test is to establish the effectiveness of the questionnaire (Hunt, Sparkman & Wilcox, 1982). Other than testing for the effectiveness, Hunt et al. (1982) also posited that pre-test is an alternative way in determining the response rate.

Thus, in order to prevent the survey questions from being misinterpreted or misunderstood, the questionnaires were first distributed to 30 respondents to gauge their understandings on each of the questions for this research study. The sample size of 30 was in accordance with past literature (e.g., Bolton,1993; Perneger, Courvoisier, Hudelson & Gayet-Ageron, 2015).

Besides, the pre-test conducted in this study allowed the respondents to comment on the questionnaire in terms of the clarity, measuring scales, layout, sequence and wordings used for the questions. By doing so, any vague or confusion regarding the questions such as loaded questions (questions which contain false assumption and forcing respondents to indicate answer than the original answer that they would give), double-barreled questions (questions which discuss two issues at once, but require only an answer), ambiguous questions (questions which possess more than two interpretations), inappropriate usage of words and the missing answers in multiple-choice questions were identified and modified. This is incredibly critical as the content validity and criterion validity of the survey instruments were achieved and well-established. Consequently, the response error was minimised, which then increased the response rate.

Upon the completion of the pre-test, amendments on the questionanires were made based on the comments or suggestions obtained from the pre-test. A pilot test was then conducted prior to the collection of data for the actual survey. In fact, pilot test is of utmost importance as the reliability of the research instruments in the questionnaire can be tested (refer to Section 3.3.1.1). Al Muala (2010) stressed that the results of a pilot test can help the researcher in designing a perfect questionnaire. Hence, for the purpose of this study, a total of 77 questionnaires was administered as a pilot test to the drivers in Kuching.

The actual survey was carried out once the pilot test data were analysed, and that the items in the questionnaire has been decided whether or not to be dropped or retained in the actual survey questionnaire, based on the requirement of the internal consistency (Cronbach's Alpha). Overall, a total of 624 questionnaires (excluding the respondents of pilot test) was administered in-person by the researcher of the final and validated version of the questionnaire, and it was conducted not only in Kuching but Kuala Lumpur as well in order to yield a greater response. One crucial point to note that is, even though it has been mentioned in the previous section (refer to Section 3.2.4.2) that 770 questionnaires were required in the actual survey, the researcher only managed to obtain 624 responses within the stipulated timeframe as many refused to participate. Out of the 624 respondents, 300 respondents were from Kuala Lumpur and another 324 questionnaire were obtained from the respondents in Kuching.

In alignment with the purpose of the present study, simple random sampling was undertaken to distribute the questionnaire. The respondents were selected randomly in such a way that each of them had the same probability or equal chance of being selected. However, in the case of this research, it is noteworthy that a screening interview was conducted prior to distributing the questionnaire to a particular respondent. This is to ensure that only the eligible respondents were qualified to participate, and not just merely for the sake of data collection process. This compulsory procedure had to be executed carefully so as to ensure the reliability and validity of the data collected. Thus, in order to eliminate biased sample, the respondents must have fulfilled the following selection criteria, before they were allowed to participate in this research:

1. They are 17-years old and above and have already acquired a valid Malaysian Driving License.
2. They are being the drivers.
3. They do engage in mobile phone usage while driving, regardless of making or receiving phone calls or texting.

Those who were not chosen to answer the questionnaire indicated that they have failed to achieve the selection criteria. All respondents were informed of the intention of this research and were assured of their confidentiality and anonymity. Hence, they responded on a voluntary basis.

3.3 Data Analysis

3.3.1 Analysis for Pilot Test

3.3.1.1 Internal Reliability

Reliability analysis is a measurement of the overall consistency of the measuring items that are used to define a scale. According to Hair et al. (2006), reliability is defined as an "assessment of the degree of consistency between multiple measurements of the variables". Therefore, for the present study, the internal consistency of the measuring instruments pertaining to the aforementioned three driving error constructs were quantified twice (phone call and texting) via the Cronbach's alpha coefficient in ensuring that the items in the questionnaire were reliable and free from error. A Cronbach's alpha value is suppressed at the minimum threshold of 0.7 and above. In simpler term, an item equals to or greater than 0.7 indicates high internal consistency and would be retained in the questionnaire for field study. In contrast, a Cronbach's alpha value below 0.7 indicates unreliable scale (Field, 2006).

3.3.2 Analysis for Field Study (Actual Survey)

A field study was carried out after which the internal consistency of the survey instruments of DDB associated with mobile phone usage has been completed, and that the final questionnaire was revised thoroughly based on the results obtained from pilot test. The data collected during the field study were then analysed using different analysis methods in order to answer the research questions and achieve the objectives which have been set forth in this study.

In the case of current research, RQ1 looked into the pattern of the respondents' DDB, thus the data were presented in the descriptive form. Meanwhile, for RQ2, it followed the same procedure as in RQ1, whereby the descriptive statistics were computed. A comparison between the mean scores of each of the 14 items under two different types of mobile phone usage (phone call and texting) while driving were carried out. Based on the respective mean scores of items, the main driving error constructs contributed to phone call and texting were identified. When the identification of the categories of driving errors had been done, the analysis was further proceeded by means of an innovative multivariate analysis technique, which is the Binary Logistic Regression using SPSS. This investigated the relationship between other DDB variables (e.g., age, gender, occupation, driving experience, frequency of usage and traffic conditions) and the likelihood of the occurrence of road violations, cognitive errors and action errors among the drivers.

However, prior to the analysis, the sample with the 624 data set was first split randomly into two sub-samples, 60% (365 cases) of analysis (estimation) sample and another 40% (259 cases) of holdout (validation) sample. This is also known as split-sample validation method. Generally, there is no specific guideline in determining the percentage of both sub-samples during the data splitting process. The general rule of thumb is 60-40, and that the final sample sizes in both groups, especially the holdout sample, must be ensured that they are sufficient to support the number of independent variables in the model (Hair et. al, 2006). The 60-40 split used in the study was deemed important as previous researchers (e.g., Midi, Rana & Sarkar, 2010) have also utilized this in validating the binary logistic regression model.

3.3.2.1 Descriptive Statistics

Descriptive statistics are the first step in the analysis of data in a research process. As discussed by Salkind (2012) and Holcomb (2017), descriptive statistics are used to outline the general characteristics or depict the distribution of scores of a set of data collected from a population of interest or sample. The distributions of scores are normally computed through the measures of central tendency (mean, median and mode), measures of dispersion or variation (range, standard deviation) and lastly, the standard scores. For this research study, the descriptive statistics were displayed in terms of the mean, standard deviation, frequency and percentages.

3.3.2.2 Binary Logistic Regression

Logistic Regression is one of the most prominent and comprehensive quantitative data analysis techniques which is used to identify how a set of independent or explanatory variables predict the categorical outcomes of two or more categories (Pallant, 2013). According to Washington, Karlaftis and Mannering (2010), the response variable is the population proportion or probability, P, which is coded using a binary indicator variable of 1 and 0, and that the observed outcome of 1 is the presence of the characteristics of interest.

In this instance, the continuous dependent variable of the identified driving error (which have been computed through mean and standard deviation) under each mobile phone condition was recoded into a dichotomous or binary (yes/no), using the midpoint of the measurement scale as splitting point, such that 1-5 indicated ‘no’ and 6-10 indicated ‘yes’. Hence, a conclusion has reached that binary logistic regression is the most appropriate to be employed in order to further identify the relative importance of each DDB variable on the likelihood of driving errors.

The logistic regression model has the form as given by Equation 3.2 below:

$$\boldsymbol{\pi(x) = P = \frac{e^{\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \dots + \beta_K X_{K,i}}}{1 + e^{e^{\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \dots + \beta_K X_{K,i}}}}} \tag{3.2}$$

Where;

P = the probability that a case is in a particular category;

β_0 = the model constant;

$\beta_1, \dots, \beta_K$ = the coefficient of the independent variables and;

X_k = the set of independent variables (k = 1, …, K)

The transformation of the π(x) logistic function is the logit transformation (LN of the odds) which can be expressed in Equation 3.3 as below:

$$\boldsymbol{Y_i = \text{logit}\,(P_i) = \text{LN}\,\frac{P_i}{1 - P_i} = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \dots + \beta_k X_{k,i}} \tag{3.3}$$

It should be noted that a logistic curve is used to represent the relationship between the independent and dependent variables (Hair et. al., 2006). In other words, the logistic curve gives information on the probability of independent variables. According to Hair and colleagues, the probability will approach 0, but never reaches 0 when there is a decrease in the independent variable. Similarly, when the independent variable increases up the curve, the slope decreases to ensure that the probability approach 1 but never exceed it. The logistic regression equation is therefore approximately linear in the middle rangers and logarithmic at extreme values (Washington et al., 2010). Using Equation 3.3, the following statistic (Equation 3.4) can be obtained:

$$\boldsymbol{\left(\frac{P_i}{1 - P_i}\right) = e^{\beta_0 + \beta_i X_i} = e^{\beta_0} \times e^{\beta_i X_i}} \tag{3.4}$$

The relationship between the independent variables and the dependent variable in a logistic regression model is quantified through odds ratio. The odds ratio is the ratio of the odds for the independent variables being present to the odds of not being present in the model. When the independent variable X_i increases by one unit, the odds of $\frac{P_i}{1-P_i}$ increases by a factor of $e^{\beta i}$, all other factors being equal. This factor is known as the odds ratio (Odds ratio > 1 = increases; OR < 1 = decreases) and is illustrated as Equation 3.5 below (Washington, 2003):

$$\left(\frac{P_i}{1-P_i}\right) = e^{\beta 0 + \beta i(Xi+1)}$$

$$= e^{\beta 0} \text{ x } e^{\beta i Xi} \text{ x } e^{\beta i}$$

$$= e^{\beta i} \tag{3.5}$$

Therefore, in the context of this study, when the odds ratio of any significant independent variable is greater than 1, the likelihood of the occurrence of driving errors tends to increase. Likewise, an odds ratio value of lesser than 1 indicates the lower likelihood in the resulting outcome.

3.4 Model Description

As mentioned, the outcome variable (occurrence of driving errors) was collapsed and categorized as either yes (coded 1) or no (coded 0). The predictors were categorical except for driving experience, which has been identified as the only continuous variable. Besides, based on the past findings (refer to Section 2.5.1), it should be noted that the age of respondents is categorised into three different age groups. The dependent and independent variables which were used in the model development were summarised and tabulated in Table 3.4 and Table 3.5.

Table 3.4: Description of Dependent Variable

No.	Dependent Variable	Coding/Value
1	Driving Errors (Road Violations, Cognitive Errors and/or Action Errors	0 = No 1 = Yes

Table 3.5: Description of Independent Variables

No.	Independent Variables	Coding/Value
1	Age	1 = < 25 (Young) 2 = 25-64 (Middle-aged) 3 = > 65 (Old)
2	Gender	0 = Female 1 = Male
3	Occupation	1 = Accounting/Finance 2 = Admin/Human Resources 3 = Arts/Media/Communications 4 = Building/Construction 5 = Computer/Information Technology 6 = Driver 7 = Education/Training 8 = Engineering 9 = Healthcare 10 = Homemaker/Housewife 11 = Hotel/Restaurant 12 = Manufacturing 13 = Retiree 14 = Sales/Marketing 15 = Sciences 16 = Self-employed 17 = Services 18 = Student
4	Driving Experience	Continuous Variable
5	Frequency of Usage	1 = Once or twice 2 = On a few occasions 3 = Fairly often 4 = Very frequently

Table 3.5 continued

No.	Independent Variables	Coding/Value
6	Traffic Conditions	1 = Stopping at a traffic light 2 = Driving on a straight road 3 = Slow-moving traffic

From Table 3.5, it is obvious that some of the categorical variables had several levels, age group, for instance, was classified into level 1, 2 and 3. This is where the dummy variables came into the picture. As discussed by Al-Ghamdi (2002), the design variable is coded *k* – 1 for the *k* levels of the nominal scale of that variable. Thus, the age group had a total of (3 - 1 = 2) design variables. When the respondent is '1 = < 25 (Young)', the '2 = 25-64 (Middle-aged) and 3 = > 65 (Old)' would all be set to 0. It should be noted that SPSS worked in a similar nature for categorical predictors, which is through the setting of which group to be used as the reference category during the execution of logistic regression procedure.

3.5 Validation of Binary Logistic Regression Model

3.5.1 Proportional Chance Criterion

In interpreting the validity of the results obtained, it is imperative that external validity and practical significance of the logistic regression model are assessed through the examination of the percentage correctly classified (hit ratio) of holdout sample and comparison with the standard, which is the proportional chance criterion in this case. The proportional chance criterion is selected as the comparison standard because it correctly identifies members of all groups equally well. The formula of this criterion is as follows:

$$C_{PRO} = p^2 + (1 - p)^2 \tag{3.6}$$

Where;

p = proportion of individuals in group 0 (No)

$1 - p$ = proportion of individuals in group 1 (Yes)

Furthermore, it is noteworthy that the achieved classification accuracy ought to be at least 25% greater than that achieved by chance in ensuring the significance of the model. Hence, the validity of the logistic regression model is said to be achieved when the actual prediction accuracy exceeds the threshold value of the proportional chance criterion (Hair et al., 2006).

3.6 Summary

This chapter discussed the research design that comes with the methodology in obtaining the data and analysis for the present study. Moreover, the analysis of Binary Logistic Regression was covered. The development of research methodology was essential and deemed important as the step-by-step procedures ensured that the research findings could be addressed and thus answered the research questions.

CHAPTER 4

RESULTS AND DISCUSSION

Chapter four addresses the results from the in-depth analysis of the pilot test and field study (actual survey) data. Additionally, detailed interpretations and discussion are also provided at a later stage.

4.1 Pilot Test

As mentioned in the previous chapter, a pilot test ought to be conducted prior to the actual survey, and the reliability of the research instruments (items) used in designing the questionnaire would be tested upon the completion of the pilot study.

4.1.1 Internal Consistency

The internal consistency of the research instruments in the present study was assessed by computing the Cronbach's Alpha reliability coefficient. As discussed in Chapter 3, when the Cronbach's Alpha value is greater than 0.70, reliability is said to be achieved. Table 4.1 and Table 4.2 summarised the reliability statistics and item-total analysis of all the respective driving errors constructs of phone call and texting, respectively.

The Cronbach's Alpha value across the items read 0.920, which have exceeded the range of the suggested value. It can therefore be said that the driving error construct of phone call used in the questionnaire had excellent internal consistency reliability.

Table 4.1: Reliability Statistics and Item-Total Analysis of Driving Error Construct (Phone Call)

Cronbach's Alpha	0.920				
N of Items	14				
Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	**Corrected Item-Total Correlation**	Squared Multiple Correlation	**Cronbach's Alpha if Item Deleted**
Exceed Speed Limit	50.21	607.614	**.471**	.384	**.920**
Red Light Running	49.38	571.027	**.655**	.630	**.914**
Misjudge Gap when Turning	50.31	591.191	**.651**	.654	**.914**
Travelling Too Fast for Turn	50.65	589.257	**.718**	.640	**.912**
Fail to See Pedestrian on Crossing	51.38	604.948	**.618**	.975	**.915**
Lane Excursions	49.19	588.264	**.607**	.624	**.916**
Brake Late and Hard	50.40	579.665	**.697**	.665	**.912**
Leave Indicator on After Turning Complete	49.60	557.902	**.772**	.770	**.909**
Assume an Action is Legal When Not	51.30	603.160	**.640**	.975	**.915**
Accelerate too Fast	49.66	571.016	**.667**	.730	**.914**
Indicate too Early Before A Turn	51.04	583.327	**.678**	.722	**.913**
Fail to Indicate When Turning	51.14	589.914	**.626**	.761	**.915**
Press Accelerator when Trying to Brake	51.29	605.338	**.706**	.749	**.914**
Following too Close with Leading Vehicle	50.51	596.385	**.572**	.544	**.917**

Aside from the Cronbach's Alpha coefficient, the output of the **Corrected Item–Total Correlation** and the **Cronbach's Alpha if Item Deleted** are of great interest. The former is the degree to which each item correlates with the total score. The low item-total correlation values (r less than 0.30) indicated that that particular item is measuring something different from the summated scale score, and should be considered to be removed from the scale if the overall value of Cronbach's Alpha is also less than 0.70 (Pallant, 2013). From Table 4.1, it can be seen that all 14 items had the correlation values above 0.30, suggesting that the items were worthy of retention.

The **Cronbach's Alpha if Item Deleted** gives the Alpha coefficient value if an individual item is removed from the scale. If any of the values in this column are higher than the final value, the problematic item ought to be considered whether or not to be dropped out from the scale (Pallant, 2013). As shown in Table 4.1, removing any items did not result in the increase of the Cronbach's Alpha coefficient value, which signified the research instruments were reliable.

Table 4.2: Reliability Statistics and Item-Total Analysis of Driving Error Construct (Texting)

Cronbach's Alpha	0.914				
N of Items	14				
Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	**Corrected Item-Total Correlation**	Squared Multiple Correlation	**Cronbach's Alpha if Item Deleted**
Exceed Speed Limit	55.56	656.645	**.536**	.467	**.912**
Red Light Running	54.68	642.696	**.600**	.514	**.909**
Misjudge Gap when Turning	54.95	641.471	**.623**	.654	**.909**

Table 4.2 continued

Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	**Corrected Item-Total Correlation**	Squared Multiple Correlation	**Cronbach's Alpha if Item Deleted**
Travelling Too Fast for Turn	55.75	633.004	**.770**	.731	**.904**
Fail to See Pedestrian on Crossing	56.23	646.866	**.611**	.651	**.909**
Lane Excursions	52.82	661.045	**.501**	.639	**.913**
Brake Late and Hard	54.48	629.648	**.609**	.632	**.910**
Leave Indicator on After Turning Complete	54.61	618.951	**.725**	.777	**.905**
Assume an Action is Legal When Not	56.42	656.193	**.638**	.981	**.908**
Accelerate too Fast	54.55	630.514	**.674**	.794	**.907**
Indicate too Early Before A Turn	56.06	639.088	**.655**	.678	**.907**
Fail to Indicate When Turning	56.03	634.210	**.695**	.775	**.906**
Press Accelerator when Trying to Brake	56.45	660.225	**.608**	.981	**.909**
Following too Close with Leading Vehicle	55.68	652.485	**.571**	.566	**.910**

On the other hand, the overall internal consistency of driving error construct of texting records a value of 0.914, which also translated to excellent reliability. For the **Corrected Item–Total Correlation**, Table 4.2 shows that the correlation values of the entire items exceeded 0.30. Therefore, none of the items were problematic. Lastly, from the **Cronbach's Alpha if Item Deleted** column, it could be seen that the Cronbach's Alpha coefficient value did not increase if any item was removed, proving that the research instruments used to measure the driving error under texting condition were reliable.

4.1.2 Summary

As all items across the driving errors construct of both phone call and texting conditions were extremely crucial, in which they made up a large portion of the questionnaire instrument of this research, hence, having great reliability would yield a more consistent and accurate statistical results. As indicated by the results of the current pilot test, all items were reliable in terms of internal consistency (Cronbach's Alpha > 0.70) and they were fit to be retained in the actual survey questionnaire.

4.2 Field Study (Actual Survey)

In the field survey, 624 valid questionnaires were collected. The completed questionnaires were strictly checked and screened with respect to the research questions, aim and specific objectives in Chapter 1 and then processed for extensive analysis using the procedures as outlined in Chapter 3. The findings from the actual survey were introduced in the next section of this chapter.

4.2.1 Statistics on the Respondents' Demographic

4.2.1.1 Age

There were 624 respondents recruited in this research study. Their age ranged from 18 to 71 years old, with the mean score of 33.31 years and a standard deviation of 12.794. In terms of the age groups, Figure 5.1 explicates the classification of respondents based on the three different categories: young (< 25 years old), middle-aged (25-64 years old) and old (> 65 years old).

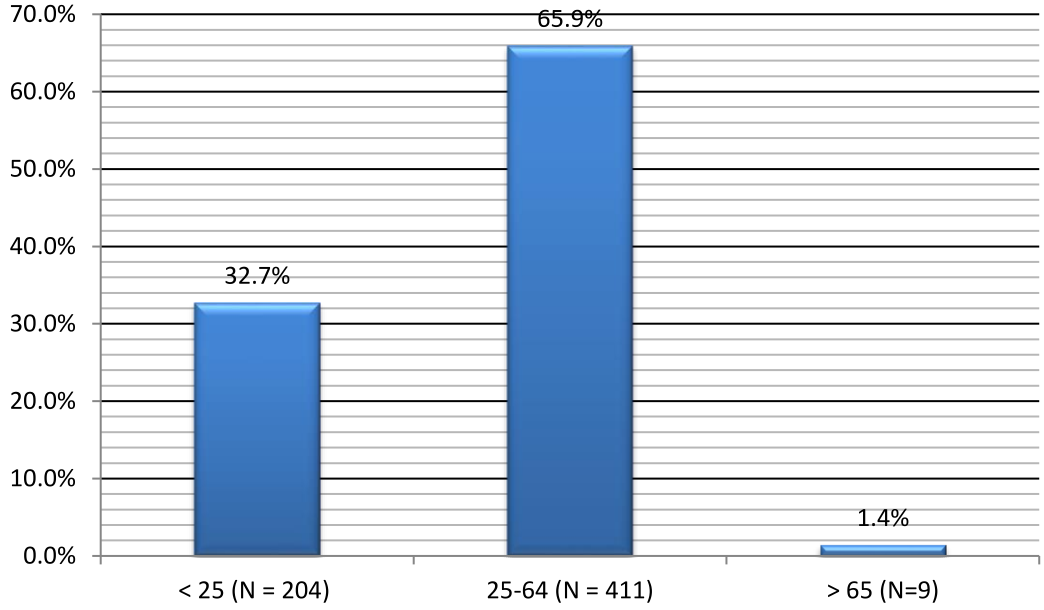

Figure 4.1: Respondents by Age Group

From Figure 4.1, it is evident that those whose age range of between 25 to 64 years old (middle-aged) made up the largest group, with 65.9 percent having engaged in mobile phone usage while driving. Young respondents (< 25 years old) turned out to be the second highest, constituted for 32.7 percent, whilst the remaining 1.4 percent of respondents are represented by those above 65 years old (old).

4.2.1.2 Gender

Figure 4.2 exhibits the proportion of gender in this study. It appears that, the number of male respondents was almost tied with that of female respondents, with the former taking up 54 percent (336 males) and the latter, the rest of the pie chart (288 females), giving a total of 624 respondents.

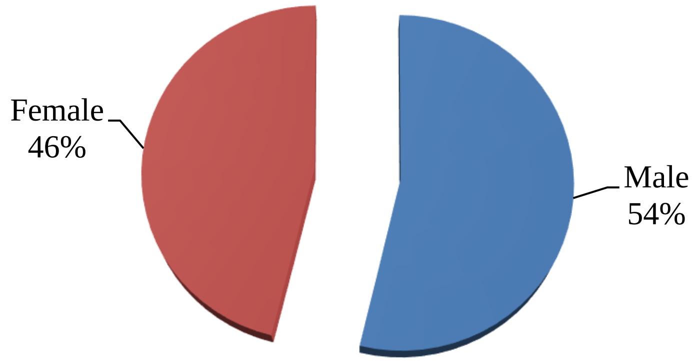

Figure 4.2: Respondents by Gender

4.2.1.3 Ethnicity

Based on Figure 4.3, the breakdown of respondents' by ethnicity, the vast majority of the respondents were Chinese, 58 percent (n = 363). This is followed by Malay respondents, accounted for a total of 28 percent (n = 175). Respondents classified in the others category, including Iban, Bidayuh, Kadazan, Melanau and Dusun marked 9 percent (n = 57), while Indian respondents made up the smallest ethnic group, in which they only registered 5 percent (n = 29) of the overall respondents in this study.

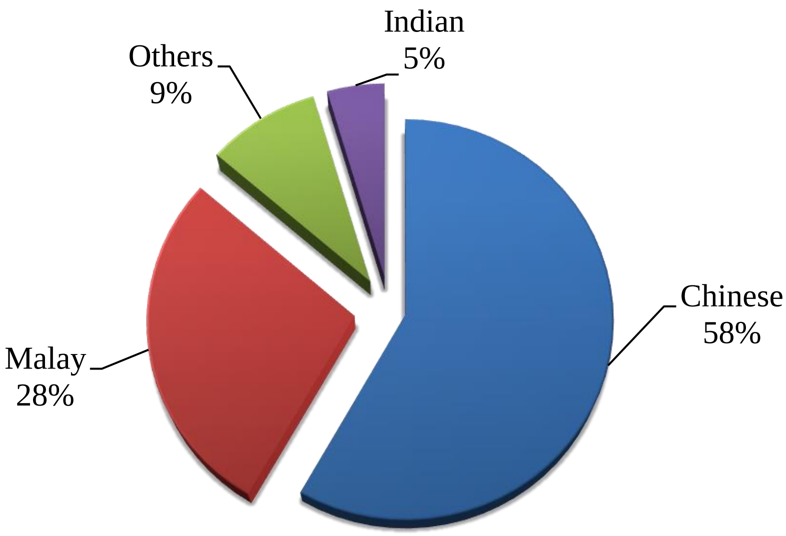

Figure 4.3: Respondents by Ethnicity

4.2.1.4 Occupation

Figure 4.4 reveals that among the 624 respondents, working individuals and students accounted for 75 percent (n = 462) and 22 percent (n = 140), respectively. Meanwhile, homemaker or housewife (n = 15) and retirees (n = 7) made up only 3 percent of the total number of respondents. Out of the 75 percent of the working individuals, the largest group were those in the sales/marketing, which recorded 10 percent (n = 61). This is followed by the 9 percent (n = 57) and 8 percent (n = 47) of respondents whom working in the services industry and admin/human resources. The fourth largest group constituted of 7 percent (n = 44) of engineers. In contrast, very few, roughly 2 percent (n = 10) of them were working in the hotel/restaurant industry.

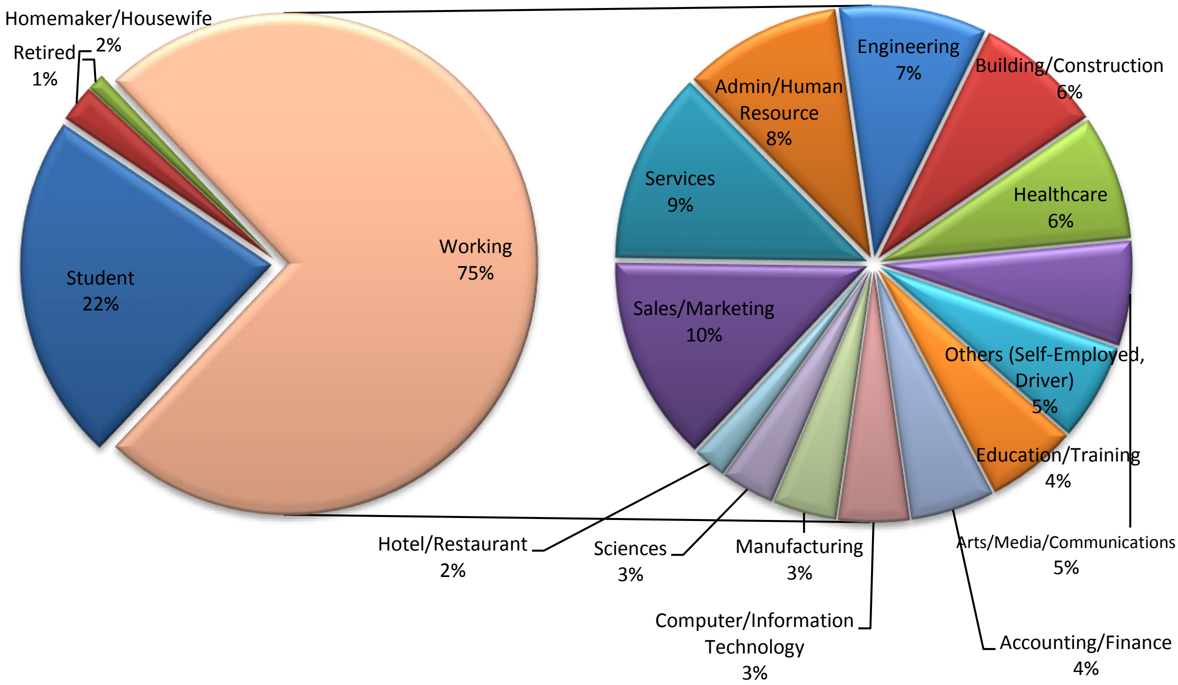

Figure 4.4: Respondents by Occupation

4.2.1.5 Driving Experience

The respondents' driving experience in the sample ranged between 0.25 years (3 months) to 53 years, with a mean of 13.71 and standard deviation of 12.354.

4.2.2 DDB Associated With Mobile Phone Usage

Undeniably, the drivers were aware of the riskiness of mobile phone usage while driving, as this can be seen when they were asked to rate the level of risk on a scale of 1 to 10 when mobile phone is being used while driving. The mean risk rating was very high, 8.59, with a standard deviation of 1.897.

Although the majority of drivers perceived the danger of using a mobile phone while behind the wheel, this mobile phone behaviour had become common among them. In fact, this is supporting the findings of earlier studies by Nelson et al. (2009) and Atchley et al.

(2011). The former found that drivers may still initiate and answer a phone call if they believed that the conversations were important, and the likelihood to drive under such driving condition tend to increase. The latter, also concluded that the perception of danger had little or no effect on the reduction of texting behaviour among drivers while driving, regardless of whether to initiate, reply or read text messages.

Figure 4.5 presents the frequency of drivers engaging in such behaviour while driving, and the response options were categorized into four levels, namely 'once or twice', 'on a few occasions', 'fairly often' and 'very frequently'.

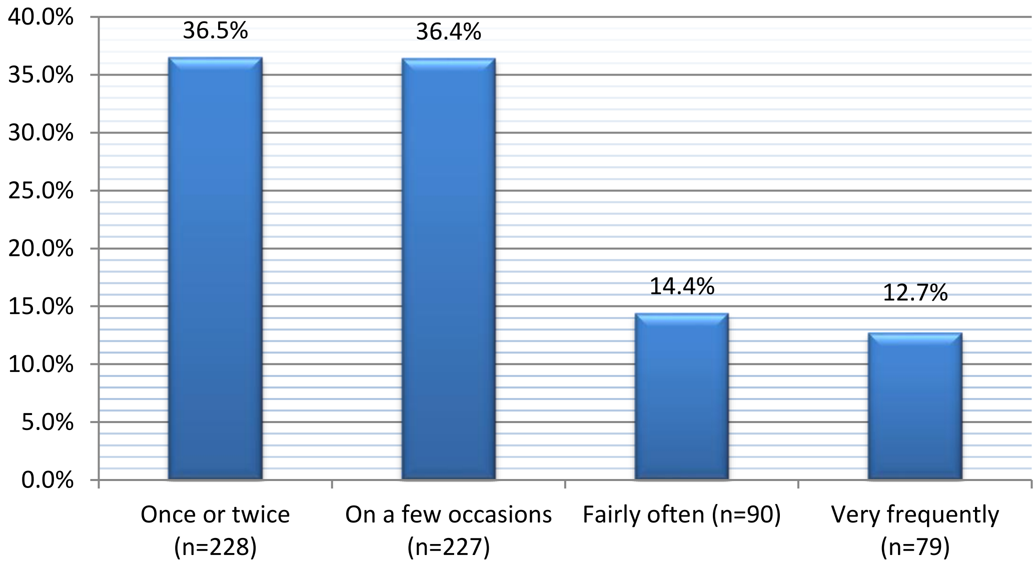

Figure 4.5: Mobile Phone Usage While Driving by Frequency

Based on the figure above, it is found out that 36.5 percent (n = 228) of the drivers reported that they 'once or twice' engaged in mobile phone usage while driving, followed by 36.4 percent (n = 227) whom admitted to engage in this behaviour 'on a few occasions'. On the contrary, there were about 27.1 percent (n = 169) of drivers who reported that they 'fairly often' and 'very frequently' to engage in mobile phone while driving. Comparatively speaking, it can be deduced that while the intentions to engage in the behavior of using a mobile phone while driving has not decreased, most of the drivers, however, would self-regulate by decreasing the frequency of use, realizing the action is dangerous.

In order to further understand the trend or pattern of DDB in Malaysia, this study also looked into the purposes of mobile phone usage while driving among drivers, which is as demonstrated in Figure 4.6.

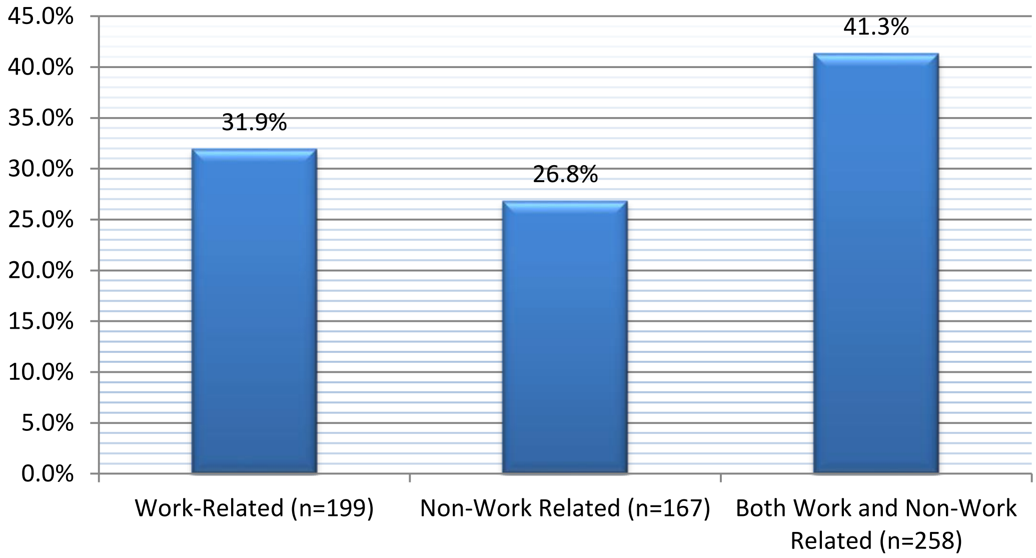

Figure 4.6: Mobile Phone Usage While Driving by Purposes

Of the 624 drivers who were involved in DDB associated with mobile phone usage, 41.3 percent (n = 258) of them reported that they use mobile phone for both work and non-work related, whilst work-related made up the second highest, in which it comprised of 31.9 percent (n = 199). Non-work related (for personal or social), on the other hand, was the least (26.8 percent) as compared to the other two sub-groups.

In addition, in terms of the likelihood of engaging in mobile phone usage while driving under different traffic conditions, more than half of drivers (57.9 percent) was more likely to engage in mobile phone while stopping at a traffic light, and less likely to do so when driving on a straight road (13.9 percent). Other than that, Figure 5.7 further reveals that more than one-quarter (28.2 percent) of the drivers engaged in such behaviour when there is slow-moving traffic. In other words, when the traffic is congested.

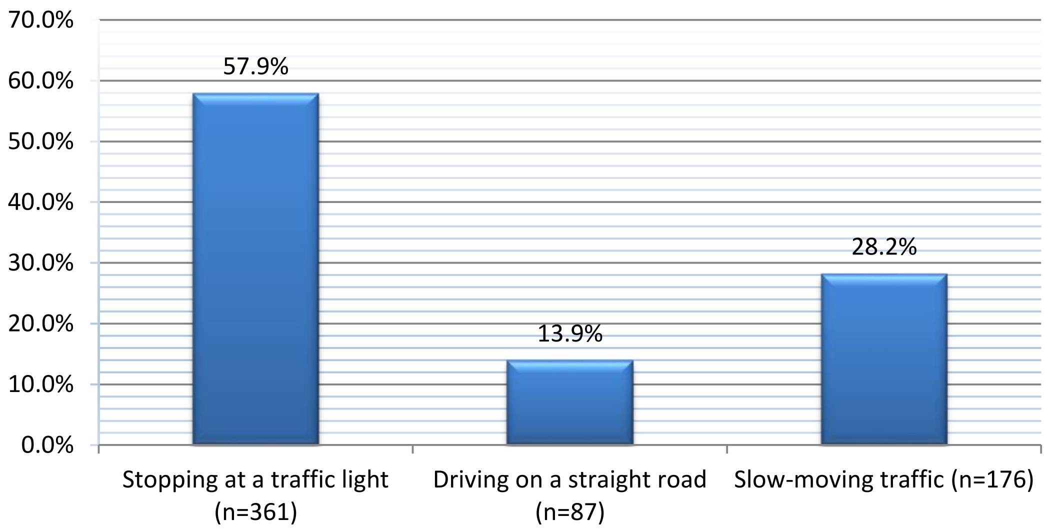

Figure 4.7: Mobile Phone Usage While Driving by Traffic Conditions

Over and above that, this survey appeared contradictory because it is found that only 11 percent (n = 68) of drivers admitted to have been involved in road traffic crashes as a result of distractions caused by the use of mobile phone while driving, as compared to the 89 percent (n=556) whom did not experience any road traffic crashes due to mobile phone distractions (refer to Figure 4.8).

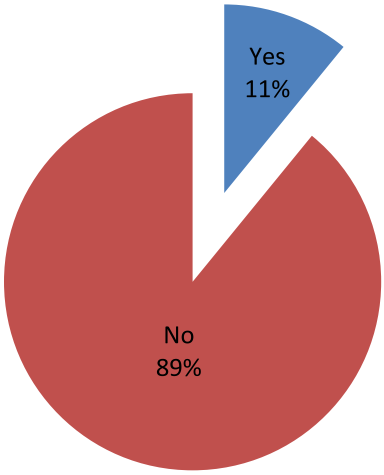

Figure 4.8: Road Traffic Crashes due to Mobile Phone Usage While Driving

As seen from the results, the very low number of road traffic crashes resulted from mobile phone distractions might be the reason behind the increasing number of DDB associated of mobile phone usage today. This is because the drivers who do not experience any distraction-related crashes tend to underestimate the effects of distraction. They may be overconfident and deem that their driving performance is not affected as they can still control their vehicles and manage the safety risks when the mobile phone is used.

4.2.3 Impacts of DDB Associated With Mobile Phone Usage on Driving Errors

There is extensive evidence that DDB associated with mobile phone usage results in the buildup of critical driving errors which elevate the risks of a crash or near crash. However, how different types of mobile phone activities, such as phone call and texting while driving increase the likelihood of the occurrence of errors are of great interest in this study. For that reason, it is crucial to take into account the key questions regarding the adverse impacts of both types of mobile phone usage in order to further understand to what extent each error is commonly committed by the drivers, and also across three error categories of road violations, cognitive errors and action errors.

Based on the data collected from the questionnaire, the mean scores of each of the 14 items assessed on a scale of 1 to 10 in both phone call and texting conditions, were computed and presented in Table 4.3 and Table 4.4, respectively.

Table 4.3: The Underlying Driving Errors with Respective Mean Scores and Standard Deviations during Phone Call

Items	Mean	Standard Deviation
Red Light Running (RV)	**5.10**	**2.674**
Fail to Indicate When Turning (AE)	**5.03**	**2.512**
Lane Excursions (CE)	**5.00**	**2.537**
Brake Late and Hard (CE)	3.98	2.753
Indicate too Early before a Turn (AE)	3.65	2.560
Leave Indicator on After Turning Complete (CE)	3.36	2.469
Exceed Speed Limit (RV)	3.31	2.776
Following Too Close with Leading Vehicle (AE)	3.29	2.610
Misjudge gap when turning (CE)	3.01	2.689
Accelerate too fast (AE)	2.92	2.548
Travelling too fast for turn (CE)	2.83	2.448
Fail to see pedestrian on crossing (CE)	2.62	2.503
Assume An Action is Legal When Not (CE)	2.59	2.439
Press Accelerator When Trying to Brake (AE)	2.57	2.410

As observed on the Likert-scaled items, the most reported driving error across the phone call behaviour was red light running (M = 5.10, SD = 2.674). This is followed by a failure to indicate when turning (M = 5.03, SD = 2.512) and lane excursions (M = 5.00, SD = 2.537). On the contrary, the other 11 errors were found less likely to be made among the drivers in this study. From the results, it can be summarised that road violations had been found to be the strongest impacts, whilst action errors and cognitive errors did not come in as strong as the road violations when drivers reported having phone conversations while driving. Although previous studies (e.g., McKnight & McKnight, 1993; Strayer et al., 2003) concluded that mobile phone conversations while driving tend to increase the reaction time, which then lead to the scenario of performing late and harsh braking, but such an error was not found in this study.

Moving into the underlying driving errors across the texting behaviour, the full results were highlighted in Table 4.4. The most obvious difference to note is that, the mean rating for each driving error was much higher than that of phone call while driving. This is in good agreement with the U.S. Department of Transportation (2011) which pointed towards texting as the most DDB.

Table 4.4: The Underlying Driving Errors with Respective Mean Scores and Standard Deviations during Texting

Items	Mean	Standard Deviation
Brake Late and Hard (CE)	**6.19**	**3.042**
Lane Excursions (CE)	**6.13**	**2.686**
Red Light Running (RV)	**5.15**	**2.823**
Fail to Indicate When Turning (AE)	**5.08**	**2.825**
Indicate too Early before a Turn (AE)	4.36	2.748
Leave Indicator on After Turning Complete (CE)	3.81	2.493
Exceed Speed Limit (RV)	3.43	2.676
Misjudge gap when turning (CE)	3.35	2.900
Press Accelerator When Trying to Brake (AE)	3.33	2.770
Following Too Close with Leading Vehicle (AE)	3.06	2.784
Accelerate too fast (AE)	3.00	2.521
Fail to see pedestrian on crossing (CE)	2.96	2.723
Travelling too fast for turn (CE)	2.76	2.431
Assume An Action is Legal When Not (CE)	2.74	2.407

From the analysis, it is apparent that the four most prevalent errors committed by drivers were brake late and hard (M = 6.19, SD = 3.042), lane excursions (M = 6.13, SD = 2.686), red light running (M = 5.15, SD = 2.823) and fail to indicate when turning (M= 5.08, SD = 2.825). On the other hand, it is least likely that the drivers assumed an action is legal when it is not (M = 2.74, SD = 2.407) among all other errors. In terms of the specific categories of driving errors, the finding provides evidence that texting while driving also resulted in road violations, cognitive errors and action errors. The drivers, however, were significantly more likely to perpetrate two types of cognitive errors (brake late and hard and lane excursions) when they texted and drive, as compared to only one (lane excursions) when they were on phone calls.

What is interesting is that out of the four different types of driving errors, three were identified to be the same as that of phone calls while driving. These include lane excursions, red light running and fail to indicate when turning. Despite the same error types, significant differences do exist between the two DDB, which is the degree and the ranking of each individual error as mentioned above. For example, the occurrence of lane excursions accounted for a higher degree and ranked the second highest in texting compared to phone call. Similarly, past studies have shown evidence that drivers tend to experience even greater impacts when they were to text and drive (Libby & Chaparro, 2009; Hosking et al., 2009).

When comparing the error types in both phone call and texting, the frequent observed errors in the current study were in line with those distraction studies which have been discussed in Chapter 2. In spite of prior evidence, the errors, except for lane excursions, found in this study, were somewhat contradicting with the study by Young et al. (2013). The authors indicated that exceeding speed limit, lane excursions, activating indicators too early and travelling too fast for turn, were common when drivers were under distractions.

Although some of the errors were found to have lesser impacts on drivers in this study, both phone call and texting while driving in general were associated with the increasing likelihood of committing road violations, cognitive errors and action errors; see Table 4.5.

Table 4.5: Summary of the Driving Errors

Phone Call		**Texting**	
Road Violations	Red light running	**Cognitive Errors**	Brake late and hard Lane excursion
Action Errors	Fail to indicate when turning	**Road Violations**	Red light running
Cognitive Errors	Lane excursion	**Action Errors**	Fail to indicate when turning

The findings above, therefore assisted in our understanding of the distraction-induced errors in relation to different types of mobile phone usage while driving. These errors, nevertheless create hazardous driving situations which potentially impair drivers in several ways and could even lead to near-crash or crash occurrences, regardless of fatal or injury crashes.

4.2.4 Other Key Parameters Associated with Driving Errors (RV, CE & AE) under Phone Call and Texting Condition

Aside from the evaluation of respondents' demographic information and the underlying driving errors normally executed by the mobile phone-distracted drivers, a statistical analysis of binary logistic regression was also performed to ascertain the ability of various factors in predicting the likelihood of the occurrence of the respective road violations, cognitive errors and action errors, under two distracted driving conditions namely, phone call and texting. As reported in section 4.2.4, the three different categories of driving errors in each distracted driving conditions were represented by the items of mean values greater than five, and they were extracted out to be used as the regression models. These include, (1) phone call: red light running (RV2), fail to indicate when turning (AE3) and lane excursion (CE4); and (2) texting: brake late and hard (CE5), lane excursion (CE4), red light running (RV2) and fail to indicate when turning (AE3). Thus, a total of seven regression models was identified and each model contained six identified independent variables, namely age, gender, occupation, driving experience, frequency of usage and traffic conditions.

It is crucial to note that the predictors, age and driving experience were included the model analysis, even though both were found to be highly correlated (correlated at 0.50 or 0.60 and above, in this case, r = 0.782); see Table 4.6. This is because a greater age does not imply a greater driving experience, as a driver may have acquired his or her driving license at an older age, thus having lesser driving experience than another driver of the same age. Additionally, it can also be seen that previous related-studies have adopted these two variables in the analysis, indicating that they are as equally important.

As outlined in Chapter 3, the samples were divided into analysis and holdout (validation) sample of 60 (365 cases) and 40 (259 cases) respectively, prior to the execution of the regression model. The results of the logistic regression models (analysis sample) are presented accordingly in the respective sub-chapters after this paragraph.

Table 4.6: Correlation Coefficients Between Independent Variables

	Age	Gender	Occupation	Driving Experience	Frequency of Usage	Traffic Conditions
1. Age	-	.201	-.391	**.782**	-.114	-.014
2. Gender		-	-.054	.280	.131	.069
3. Occupation			-	-.267	-.002	-.059
4. Driving Experience				-	-.074	-.118
5. Frequency of Usage					-	.018
6. Traffic Conditions						-

4.2.4.1 Phone Call: Road Violations (Red Light Running)

The logistic regression analysis in Table 4.7 summarises the contributions of each predictor in predicting whether or not a driver committed road violations when making a phone call. The statistical significance of the individual regression coefficients is made based on the Wald Chi-Square statistic, as well as the estimated odds ratio, e^{β}.

Table 4.7: Logistic Regression Analysis in Predicting Likelihood of Road Violations

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Age Group			1.564	2	0.458	
< 25 (Reference Category)	0.000	0.000	0.000	0	-	-
25-64	-0.167	0.417	0.161	1	0.688	0.846
> 65	2.002	1.939	1.066	1	0.302	7.404
Gender						
Male	-0.254	0.272	0.870	1	0.351	0.776
Female (Reference Category)	0.000	0.000	0.000	0	-	-
Occupation			20.712	17	0.239	
Student (Reference Category)	0.000	0.000	0.000	0	-	-
Accounting/Finance	0.525	0.645	0.660	1	0.416	1.690
Admin/Human Resources	0.895	0.568	2.477	1	0.116	2.446
Arts/Media/ Communications	0.660	0.559	1.397	1	0.237	1.935
Building/Construction	0.522	0.645	0.653	1	0.419	1.685
Computer/Information Technology	0.264	0.821	0.103	1	0.748	1.302
Driver	1.065	1.400	0.579	1	0.447	2.900
Education/Training	0.970	0.740	1.719	1	0.190	2.637
Engineering	0.774	0.608	1.623	1	0.203	2.169
Healthcare	0.285	0.588	0.235	1	0.628	1.330

Table 4.7 continued

Predictor	β	*SE* β	Wald's χ^2	*df*	*p*	e^{β}
Homemaker/Housewife	0.461	0.856	0.291	1	0.590	1.586
Hotel/Restaurant	-1.559	1.174	1.763	1	0.184	0.210
Manufacturing	0.462	0.789	0.342	1	0.559	1.587
Retiree	-21.040	27254.735	0.000	1	0.999	0.000
Sales/Marketing	**1.177**	**0.544**	**4.686**	**1**	**0.030***	**3.244**
Sciences	-1.534	1.023	2.247	1	0.134	0.216
Self-employed	-1.727	1.203	2.060	1	0.151	0.178
Services	0.949	0.569	2.783	1	0.095	2.584
Driving Experience	-0.026	0.014	3.374	1	0.066	0.975
Frequency_of_Usage			7.592	3	0.055	
Once or Twice (Reference Category)	0.000	0.000	0.000	0	-	-
On a Few Occasions	0.007	0.272	0.001	1	.979	1.007
Fairly Often	0.144	0.373	0.149	1	0.700	1.155
Very Frequently	**1.290**	**.487**	**6.999**	**1**	**.008****	**3.631**
Traffic_Conditions			4.759	2	0.093	
Stopping at a Traffic Light (Reference Category)	0.000	0.000	0.000	0	-	-
Driving on a Straight Road	**0.991**	**0.456**	**4.720**	**1**	**0.030***	**2.695**
Slow-moving Traffic	0.065	0.268	0.058	1	0.809	1.067
Constant	-0.050	0.295	0.029	1	0.866	0.951

N = 365; Cox and Snell $R^2 = 0.162$; Nagelkerke $R^2 = 0.217$; *$p < 0.05$; **$p < 0.01$

The full model containing all predictors was statistically significant χ^2 (26, N = 365) = 64.719, $p < 0.001$, indicating that the sets of independent variables significantly improved the predictive power of the model.

The Hosmer-Lemeshow goodness-of-fit statistics examines whether or not the predicted probabilities are the same as the actual probabilities. An overall goodness-of-fit of the model is indicated by a significance value greater than 0.05. In contrast, the significant value lesser than 0.05 suggests a poor fit model (Hosmer and Lemeshow, 2000). Since the *p*-value of this model was insignificant ($p = 0.159 > 0.05$), therefore, provided evidence that the model fitted the data perfectly.

It can also be concluded that the model as a whole was able to explain between 16.2 percent (Cox & Snell R^2) and 21.7 percent (Nagelkerke R^2) of the variance in the occurrence of road violations. The full model, on the other hand, correctly classified 67.1 percent of the overall cases, in which it showed an improvement of 15.0 percent over the 52.1 percent in the null model.

The Wald statistic, which has a Chi-Square distribution, denoted that frequency of usage – very frequently (Wald $x^2 = 6.999$, $p = 0.008$), occupation - sales/marketing (Wald $x^2 = 4.686$, $p = 0.030$) and traffic conditions - driving on a straight road (Wald $x^2 = 4.720$, $p = 0.030$) were the predictors which posed statistically significant contributions to the model. The rest of the independent variables, however, did not find to contribute significantly in the prediction of the likelihood of road violations when the drivers engaged in phone calls; see Table 4.7.

Additionally, the value of (e^{β}) obtained from the analysis was crucial as the corresponding odds ratio of each independent variable in the model could be determined. The odds ratio is the change in odds when there is one-unit increase in the value of independent variables. In this study, those who reported to 'very frequently' engage in mobile phone usage while driving, were 3.631 times more likely to commit road violations than that of the reference group, 'once or twice'.

Interestingly, those in the sales/marketing industry, as compared to the student (reference group), were also found to have a higher chance of committing road violations. For a unit increase in the number of drivers in this category, the odds of committing such error increased by 3.244 times. Similarly, those tend to drive while driving on a straight road was 2.695 times higher than that of while stopping at a traffic light who report committing road violations, respectively.

The final logistic model for the likelihood of road violations can be formulated as follows:

$$\text{Logit } p \text{ (Road Violations)} = -0.050 + 1.290 \text{ (very frequently)} + 1.177 \text{ (sales/marketing)} + 0.991 \text{ (driving on a straight road)} \quad (4.1)$$

4.2.4.2 Phone Call: Cognitive Errors (Lane Excursions)

For the cognitive errors made during the phone call, the significance level of each individual predictor is outlined in Table 4.8.

Table 4.8: Logistic Regression Analysis in Predicting Likelihood of Cognitive Errors

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Age Group			1.948	2	0.378	
< 25 (Reference Category)	0.000	0.000	0.000	0	-	-
25-64	0.416	0.426	0.954	1	0.329	1.516
> 65	2.098	1.665	1.588	1	0.208	8.150
Gender						
Male	0.346	0.279	1.543	1	0.214	1.414
Female (Reference Category)	0.000	0.000	0.000	0	-	-
Occupation			26.856	17	0.060	
Student (Reference Category)	0.000	0.000	0.000	0	-	-
Accounting/Finance	**2.062**	**0.865**	**5.689**	**1**	**0.017***	**7.864**
Admin/Human Resources	0.614	0.581	1.118	1	0.290	1.848
Arts/Media/ Communications	-0.655	0.535	1.503	1	0.220	0.519

Table 4.8 continued

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Building/Construction	**1.679**	**0.713**	**5.549**	**1**	**0.018***	**5.360**
Computer/Information Technology	-0.789	0.862	0.838	1	0.360	0.454
Driver	21.563	22865.613	0.000	1	0.999	2315503913.741
Education/Training	-0.092	0.738	0.015	1	0.901	0.912
Engineering	0.998	0.643	2.407	1	0.121	2.712
Healthcare	-0.233	0.599	0.152	1	0.697	0.792
Homemaker/Housewife	1.424	0.876	2.645	1	0.104	4.155
Hotel/Restaurant	-0.875	0.939	0.869	1	0.351	0.417
Manufacturing	1.275	0.855	2.225	1	0.136	3.578
Retiree	-19.733	27461.891	0.000	1	0.999	0.000
Sales/Marketing	0.594	0.529	1.261	1	0.261	1.812
Sciences	-0.610	0.878	0.482	1	0.487	0.543
Self-employed	0.372	0.759	0.240	1	0.624	1.450
Services	0.646	0.574	1.270	1	0.260	1.909
Driving Experience	**-0.072**	**0.015**	**22.431**	**1**	**0.000****	**0.930**
Frequency_of_Usage			1.571	3	0.666	
Once or Twice (Reference Category)	0.000	0.000	0.000	0	-	-
On a Few Occasions	0.062	0.277	0.050	1	0.824	1.064
Fairly Often	0.476	0.392	1.472	1	0.225	1.610
Very Frequently	0.214	0.438	0.239	1	0.625	1.239
Traffic_Conditions			0.600	2	0.741	
Stopping at a Traffic Light (Reference Category)	0.000	0.000	0.000	0	-	-
Driving on a Straight Road	0.133	0.418	0.101	1	0.751	1.142
Slow-moving Traffic	0.210	0.276	0.578	1	0.447	1.234
Constant	0.167	0.294	0.321	1	0.571	1.181

N = 365; Cox and Snell R^2 = 0.168; Nagelkerke R^2 = 0.226; *$p < 0.05$; **$p < 0.01$

The full model with independent variables was statistically significant χ^2 (26, N = 365) = 67.253, $p < 0.001$. This suggested the model as being worthwhile because the overall predictive power of the model with predictors was improved.

The Hosmer and Lemeshow Test provided evidence that the data fitted the model perfectly as the p-value ($p = 0.222$) of the model was found to be greater than the cutoff value of 0.05). It was also shown that approximately 16.8 percent (Cox and Snell R^2) to 22.6 percent (Nagelkerke R^2) of the variance in predicting whether or not drivers committed cognitive errors while having the phone call, was able to be predicted from the combination of the six independent variables.

Furthermore, the results indicated that approximately 69.9 percent of the overall cases of cognitive errors were predicted correctly, as compared to the baseline condition, which only correctly predicted 56.2 percent.

Based on the results in Table 4.8, the variables which contributed significantly to the predictive ability of the model were driving experience (Wald $x^2 = 22.431$, $p < 0.001$), occupation – accounting/finance (Wald $x^2 = 5.689$, $p = 0.017$) and occupation – building/construction (Wald $x^2 = 5.549$, $p = 0.019$).

Besides, it is evident that the respondents of this study whom working in the accounting/finance industry, as well as in the building/construction, were the two highest groups in reporting to commit cognitive errors. An increase in the number of both categories has been shown to increase cognitive errors by 7.864 and 5.360 times, respectively.

Meanwhile, the odds ratio for driving experience was 0.930. Since the value is less than 1, there is a decrease in the likelihood of committing cognitive errors for every increase in driving experience. In other words, the greater the driving experience a driver has, the odds of committing cognitive errors become smaller.

Thus, the final logistic model for the likelihood of committing cognitive errors can be formulated as follows:

$$\text{Logit } p \text{ (Cognitive Errors)} = 0.167 + 2.062 \text{ (accounting/finance)} + 1.679 \text{ (building/construction)} - 0.072 \text{ (driving experience)} \quad (4.2)$$

4.2.4.3 Phone Call: Action Errors (Fail to Indicate When Turning)

Table 4.9 presents the statistical significance of the variables in predicting the likelihood of action errors when making a phone call.

Table 4.9: Logistic Regression Analysis in Predicting Likelihood of Action Errors

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Age Group			1.278	2	.528	
< 25 (Reference Category)	0.000	0.000	0.000	0	-	-
25-64	0.494	0.457	1.169	1	0.280	1.640
> 65	1.142	1.695	0.455	1	0.500	3.134
Gender						
Male	0.150	0.291	0.264	1	0.607	1.162
Female (Reference Category)	0.000	0.000	0.000	0	-	-
Occupation			14.600	17	0.624	
Student (Reference Category)	0.000	0.000	0.000	0	-	-
Accounting/Finance	0.212	0.664	0.102	1	0.749	1.236
Admin/Human Resources	0.375	0.608	0.380	1	0.538	1.454
Arts/Media/ Communications	**1.651**	**0.806**	**4.201**	**1**	**0.040***	**5.215**
Building/Construction	-0.406	0.661	0.377	1	0.539	0.666
Computer/Information Technology	0.290	0.864	0.113	1	0.737	1.337
Driver	-0.026	1.372	0.000	1	0.985	0.974

Table 4.9 continued

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Education/Training	0.609	0.830	0.539	1	0.463	1.839
Engineering	0.990	0.727	1.853	1	0.173	2.692
Healthcare	0.995	0.676	2.166	1	0.141	2.704
Homemaker/Housewife	0.223	0.865	0.066	1	0.797	1.250
Hotel/Restaurant	-0.953	0.864	1.217	1	0.270	0.386
Manufacturing	0.397	0.845	0.221	1	0.639	1.487
Retiree	21.880	28292.179	0.000	1	.999	3180945356.544
Sales/Marketing	0.458	0.558	0.674	1	0.412	1.581
Sciences	-0.151	0.977	0.024	1	0.877	0.860
Self-employed	-0.290	0.743	0.152	1	0.696	0.748
Services	0.439	0.607	0.524	1	0.469	1.551
Driving Experience	**-0.035**	**0.014**	**6.066**	**1**	**0.014***	**0.965**
Frequency_of_Usage			2.925	3	0.403	
Once or Twice (Reference Category)	0.000	0.000	0.000	0	-	-
On a Few Occasions	0.279	0.285	0.963	1	0.327	1.322
Fairly Often	0.307	0.413	0.555	1	0.456	1.360
Very Frequently	0.818	0.508	2.589	1	0.108	2.265
Traffic_Conditions			8.421	2	0.015	
Stopping at a Traffic Light (Reference Category)	0.000	0.000	0.000	0	-	-
Driving on a Straight Road	**1.026**	**0.511**	**4.027**	**1**	**0.045***	**2.791**
Slow-moving Traffic	**0.701**	**0.294**	**5.709**	**1**	**0.017***	**2.017**
Constant	0.012	0.301	0.002	1	0.969	1.012

N = 365; Cox and Snell R^2 = 0.132; Nagelkerke R^2 = 0.185; **p* < 0.05; ***p* < 0.01

The full model was statistically significant χ^2 (26, N = 365) = 51.861, p = 0.002, suggesting that the sets of independent variables improved the overall predictive power of the model.

For the Hosmer and Lemeshow Test, the p-value of the model was insignificant, 0.498 ($p > 0.05$), which also indicated support for the model fit. Besides, it is crucial to note that the full model predicted approximately 13.2 percent (Cox and Snell R square) and 18.5 percent (Nagelkerke R square) of the variance in committing action errors.

The full model improved after the inclusion of independent variables. It was shown to correctly classify 71.5 percent of the overall cases of action errors, as compared to 67.9 percent in the null model.

Based on Table 4.9, it is denoted that driving experience (Wald x^2 = 6.066, p = 0.014), traffic conditions – slow-moving traffic (Wald x^2 = 5.709, p = 0.017), occupation – arts/media/communication (Wald x^2 = 4.201, p = 0.040) and traffic conditions – driving on a straight road (Wald x^2 = 4.027, p = 0.045) were the significant predictors in the model.

The tabulation of odds ratio showed that the occupation (arts/media/communications) was 5.215 times than that of student to commit action errors. Obviously, those who tend to use a mobile phone when driving on a straight road and in slow-moving traffic were more likely to commit action errors as compared to when stopping at a traffic light (reference group). The odds of committing action errors were 2.791 and 2.017 times greater than that of when the vehicle is static. Driving experience, on the other hand, was found to record an odds ratio of less than one (e^{β} = 0.965). This inferred that for a unit increase in the driving experience of a driver, the odds of him or her reporting red light violations decrease by a factor of 0.965, all other factors being equal.

The final logistic model for the likelihood in performing action errors can be written as follows:

$$\text{Logit } p \text{ (Action Errors)} = 0.012 + 1.651 \text{ (arts/media/communications)} + 1.026 \text{ (driving on a straight road)} + 0.701 \text{ (slow-moving traffic)} - 0.035 \text{ (driving experience)} \quad (4.3)$$

4.2.4.4 Texting: Road Violations (Red Light Running)

The sets of independent variables were tested in the model for the springing up of road violations among the texters while driving. Table 4.10 provides the information on whether or not the independent variables were contributing to the predictive ability of the road violations model.

Table 4.10: Logistic Regression Analysis in Predicting Likelihood of Road Violations

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Age Group			2.715	2	0.257	
< 25 (Reference Category)	0.000	0.000	0.000	0	-	-
25-64	0.546	0.415	1.733	1	0.188	1.727
> 65	2.458	1.852	1.762	1	0.184	11.684
Gender						
Male	-0.163	0.274	0.356	1	0.551	0.849
Female (Reference Category)	0.000	0.000	0.000	0	-	-
Occupation			12.940	17	0.740	
Student (Reference Category)	0.000	0.000	0.000	0	-	-
Accounting/Finance	0.059	0.639	0.009	1	0.926	1.061
Admin/Human Resources	0.225	0.560	0.161	1	0.688	1.252
Arts/Media/ Communications	0.781	0.572	1.863	1	0.172	2.184

Table 4.10 continued

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Building/Construction	0.373	0.637	0.343	1	0.558	1.452
Computer/Information Technology	0.246	0.828	0.088	1	0.766	1.279
Driver	20.891	22529.846	0.000	1	0.999	1182192538.414
Education/Training	0.489	0.750	0.424	1	0.515	1.630
Engineering	-0.262	0.595	0.194	1	0.660	0.770
Healthcare	0.354	0.583	0.368	1	0.544	1.425
Homemaker/Housewife	0.229	0.862	0.070	1	0.791	1.257
Hotel/Restaurant	0.293	0.847	0.120	1	0.729	1.341
Manufacturing	0.522	0.796	0.430	1	0.512	1.685
Retiree	-20.724	27453.200	0.000	1	0.999	0.000
Sales/Marketing	**1.087**	**0.549**	**3.922**	**1**	**0.048***	**2.964**
Sciences	0.292	0.974	0.090	1	0.764	1.339
Self-employed	-1.227	0.920	1.778	1	0.182	0.293
Services	0.649	0.571	1.292	1	0.256	1.913
Driving Experience	**-0.036**	**0.014**	**6.362**	**1**	**0.012***	**0.965**
Frequency_of_Usage			10.767	3	0.013	
Once or Twice (Reference Category)	0.000	0.000	0.000	0	-	-
On a Few Occasions	**0.643**	**0.272**	**5.600**	**1**	**0.018***	**1.902**
Fairly Often	**0.765**	**0.385**	**3.944**	**1**	**0.047***	**2.148**
Very Frequently	**1.278**	**0.468**	**7.472**	**1**	**0.006****	**3.590**
Traffic_Conditions			5.539	2	0.063	
Stopping at a Traffic Light (Reference Category)	0.000	0.000	0.000	0	-	-
Driving on a Straight Road	**1.098**	**0.480**	**5.221**	**1**	**0.022***	**2.998**
Slow-moving Traffic	-0.016	0.267	0.004	1	0.952	0.984
Constant	-0.486	0.299	2.642	1	0.104	0.615

N = 365; Cox and Snell R^2 = 0.165; Nagelkerke R^2 = 0.221; **p* < 0.05; ***p* < 0.01

As evident from the results, the model was statistically significant χ^2 (26, N = 365) = 65.983, $p < 0.001$, indicating that the independent variables improved the predictive power of the current model.

In general, the full model was able to predict approximately 16.5 percent (Cox and Snell R square) and 22.1 percent (Nagelkerke R square) of the variance in committing road violations while text and drive. Moving into the Hosmer and Lemeshow Test, the significance value of the full model was larger than 0.05 ($p = 0.729$), which supported the model as being justifiable. Moreover, the full model correctly classified 64.7 percent of the overall cases of road violations, in which it showed an improvement over the 55.1 percent in the null model.

From the Wald statistics column as presented in Table 5.8, the main factor influencing a driver to commit road violations when he or she text and drive was the frequency of usage – very frequently (Wald $x^2 = 7.472$, $p = 0.006$). This is followed by driving experience (Wald $x^2 = 6.362$, $p = 0.012$), frequency of usage – on a few occasions (Wald $x^2 = 5.600$, $p = 0.018$), traffic conditions – driving on a straight road (Wald $x^2 = 5.221$, $p = 0.022$), frequency of usage – fairly often (Wald $x^2 = 3.944$, $p = 0.047$) and occupation – sales/marketing (Wald $x^2 = 3.922$, $p = 0.048$). The rest of the predictors, however, did not contribute significantly to the model.

Similar to the results obtained in phone call condition, the red light violators were those who have been using mobile phone while driving on a straight road. This aberrant behaviour accounted for 2.998 times more likely to be committed than when stopping at a traffic light, and it was highly represented by the sales/marketing group of drivers. The logistic regression model indicated that for a unit increase in the number of drivers in this career to report engaging in texting while driving, the odds of running a red light was 2.964 times greater than those in the reference category, which in this case was the student.

Meanwhile, regarding the frequency of mobile phone usage (on a few occasions, fairly often and very frequently), all three had significant effects on committing road violations. Compared with the reference category (once or twice), a respondent who admitted to have engaged in mobile phone were 3.590 (very frequently), 2.148 (fairly often) and 1.902 (on a few occasions) times higher to run a red light. Driving experience, on the other hand, was found to affect the tendency of committing violations. In this case, the odds ratio recorded a value of 0.965, and was less than 1. This indicated that a driver with less driving experience was more likely to experience road violations. For every increase in the driving experience, the odds of him or her to report running red light decreased by a factor of 0.965, all other factors being equal.

The final logistic model for the likelihood of road violations can be formulated as follows:

$$\begin{aligned}\text{Logit } p \text{ (Road Violations)} = &-0.486 + 1.278 \text{ (very frequently)} \\ &+ 1.098 \text{ (driving on a straight road)} + 1.087 \text{ (sales/marketing)} \\ &+ 0.765 \text{ (fairly often)} + 0.643 \text{ (on a few occasions)} \\ &- 0.036 \text{ (driving experience)}\end{aligned} \tag{4.4}$$

4.2.4.5 Texting: Cognitive Errors (Lane Excursions)

For the cognitive errors caused by texting while driving, the contribution of each independent variable to the model is presented in Table 4.11.

Table 4.11: Logistic Regression Analysis in Predicting Likelihood of Cognitive Errors

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Age Group			2.252	2	0.324	
< 25 (Reference Category)	0.000	0.000	0.000	0	-	-
25-64	0.602	0.414	2.112	1	0.146	1.826
> 65	1.337	1.639	0.665	1	0.415	3.806
Gender						
Male	0.002	0.276	0.000	1	0.993	1.002
Female (Reference Category)	0.000	0.000	0.000	0	-	-
Occupation			14.193	17	0.653	
Student (Reference Category)	0.000	0.000	0.000	0	-	-
Accounting/Finance	-0.010	0.626	0.000	1	0.987	0.990
Admin/Human Resources	0.918	0.586	2.456	1	0.117	2.504
Arts/Media/ Communications	-0.627	0.540	1.350	1	0.245	0.534
Building/Construction	0.638	0.647	0.972	1	0.324	1.892
Computer/Information Technology	-0.920	0.849	1.173	1	0.279	0.399
Driver	20.905	23106.622	0.000	1	0.999	1199790671.040
Education/Training	0.723	0.768	0.887	1	0.346	2.061
Engineering	0.762	0.624	1.494	1	0.222	2.144
Healthcare	0.312	0.586	0.284	1	0.594	1.366
Homemaker/Housewife	0.768	0.855	0.808	1	0.369	2.155
Hotel/Restaurant	1.333	0.941	2.007	1	0.157	3.793
Manufacturing	0.399	0.789	0.255	1	0.613	1.490
Retiree	-20.003	28344.419	0.000	1	0.999	0.000
Sales/Marketing	0.662	0.524	1.598	1	0.206	1.939
Sciences	0.424	0.941	0.203	1	0.652	1.528

Table 4.11 continued

Predictor	β	*SE* β	Wald's χ^2	*df*	*p*	e^{β}
Self-employed	0.526	0.721	0.533	1	0.465	1.692
Services	1.129	0.586	3.709	1	0.054	3.094
Driving Experience	**-0.042**	**0.014**	**8.835**	**1**	**0.003****	**0.959**
Frequency_of_Usage			8.609	3	0.035	
Once or Twice (Reference Category)	0.000	0.000	0.000	0	-	-
On a Few Occasions	**0.616**	**0.272**	**5.146**	**1**	**0.023***	**1.852**
Fairly Often	**0.864**	**0.392**	**4.868**	**1**	**0.027***	**2.372**
Very Frequently	**0.911**	**0.452**	**4.073**	**1**	**0.044***	**2.488**
Traffic_Conditions			0.735	2	0.693	
Stopping at a Traffic Light (Reference Category)	0.000	0.000	0.000	0	-	-
Driving on a Straight Road	0.377	0.441	0.731	1	0.393	1.458
Slow-moving Traffic	.067	0.270	0.062	1	0.803	1.070
Constant	-0.329	0.294	1.251	1	0.263	0.720

N = 365; Cox and Snell R^2 = 0.129; Nagelkerke R^2 = 0.175; *$p < 0.05$; **$p < 0.01$

The full model with independent variables was statistically significant χ^2 (26, N = 365) = 50.523, p = 0.003. Hence, it is deduced that the model as being worthwhile because the overall model fit was improved with the addition of the six independent variables.

The full model was able to predict approximately 12.9 percent (Cox and Snell R square) and 17.5 percent (Nagelkerke R square) of the variance in the prediction of the likelihood of occurrence in cognitive errors under texting condition. The *p*-value in the Hosmer and Lemeshow Test was found to be insignificant as the value was greater than the cutoff value of 0.05 (p = 0.300). Hence, it is proven that the data obtained fitted the model well.

Moreover, there was an improvement of 8.5 percent on the full model when compared it with the null model. The former correctly classified 69.0 percent of the overall cases of cognitive errors, whilst the latter managed to correctly classify 60.5 percent of cases only.

Interestingly, the Wald statistic indicated that driving experience (Wald $x^2 = 8.835$, $p = 0.003$), frequency of usage – on a few occasions (Wald $x^2 = 5.146$, $p = 0.023$), frequency of usage – fairly often (Wald $x^2 = 4.868$, $p = 0.027$) and frequency of usage – very frequently (Wald $x^2 = 4.073$, $p = 0.044$) contributed significantly to the predictive ability of the model; see Table 5.9.

For the frequency of usage, those who reported to text and drive, in terms of 'very frequently', 'fairly often' and 'on a few occasions', were 2.488, 2.372 and 1.852 times more likely to experience lane excursions, compared with the reference category, 'once or twice'. Meanwhile, the odds ratio of 0.959 for driving experience was also less than 1, indicating that every increase in driving experience was 0.959 times less likely to report experiencing lane excursions, while controlling for other factors in the model.

The final logistic model for the likelihood of the occurrence of cognitive errors can be formulated as follows:

$$\text{Logit } p \text{ (Road Violations)} = -0.329 + 0.911 \text{ (very frequently)} + 0.864 \text{ (fairly often)} + 0.616 \text{ (on a few occasions)} - 0.042 \text{ (driving experience)} \quad (4.5)$$

4.2.4.6 Texting: Cognitive Errors (Brake Late and Hard)

The contribution of each of the independent variable in the predictive ability of the likelihood of another cognitive errors, which was found to be the incidence of brake late and hard, is presented in Table 4.12.

Table 4.12: Logistic Regression Analysis in Predicting Likelihood of Cognitive Errors

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Age Group			1.923	2	0.382	
< 25 (Reference Category)	0.000	0.000	0.000	0	-	-
25-64	0.559	0.403	1.923	1	0.165	1.748
> 65	20.346	10481.053	0.000	1	0.998	6858146 33.799
Gender						
Male	-0.119	0.269	0.196	1	0.658	0.888
Female (Reference Category)	0.000	0.000	0.000	0	-	-
Occupation			15.187	17	0.582	
Student (Reference Category)	0.000	0.000	0.000	0	-	-
Accounting/Finance	0.005	0.648	0.000	1	0.994	1.005
Admin/Human Resources	0.251	0.562	0.199	1	0.656	1.285
Arts/Media/ Communications	-0.366	0.548	0.446	1	0.504	0.694
Building/Construction	-0.913	0.631	2.094	1	0.148	0.401
Computer/Information Technology	0.723	0.927	0.609	1	0.435	2.060
Driver	20.161	22459.936	0.000	1	0.999	5701257 94.303
Education/Training	-1.477	0.766	3.716	1	0.054	0.228
Engineering	-0.421	0.592	0.505	1	0.477	0.656
Healthcare	-0.442	0.577	0.586	1	0.444	0.643
Homemaker/Housewife	-39.134	15145.296	0.000	1	0.998	0.000
Hotel/Restaurant	-0.402	0.852	0.223	1	0.637	0.669
Manufacturing	0.183	0.831	0.048	1	0.826	1.200
Retiree	-40.030	27632.299	0.000	1	0.999	0.000
Sales/Marketing	0.159	0.520	0.094	1	0.759	1.173
Sciences	-1.203	0.907	1.760	1	0.185	0.300
Self-employed	-1.217	0.762	2.553	1	0.110	0.296
Services	-0.061	0.556	0.012	1	0.912	0.941

Table 4.12 continued

Predictor	β	*SE* β	Wald's χ^2	*df*	*p*	e^{β}
Driving Experience	0.000	0.014	0.001	1	0.973	1.000
Frequency_of_Usage			21.445	3	0.000	
Once or Twice (Reference Category)	0.000	0.000	0.000	0	-	-
On a Few Occasions	**0.764**	**0.273**	**7.804**	**1**	**0.005 ****	**2.147**
Fairly Often	**1.193**	**0.384**	**9.647**	**1**	**0.002 ****	**3.299**
Very Frequently	**2.014**	**0.492**	**16.768**	**1**	**0.000 ****	**7.493**
Traffic_Conditions			0.179	2	0.915	
Stopping at a Traffic Light (Reference Category)	0.000	0.000	0.000	0	-	-
Driving on a Straight Road	0.096	0.427	0.051	1	0.821	1.101
Slow-moving Traffic	-0.080	0.272	0.086	1	0.770	0.924
Constant	-0.518	0.301	2.957	1	0.086	0.596

N = 365; Cox and Snell R^2 = 0.170; Nagelkerke R^2 = 0.227; **p* < 0.05; ***p* < 0.01

As evident from the results, the model was statistically significant χ^2 (26, N = 365) = 67.945, $p < 0.001$, indicating that the independent variables improved the predictive power of the current model.

The full model as a whole predicted approximately 17.0 percent (Cox and Snell R square) and 22.7 percent (Nagelkerke R square) of the variance in committing cognitive errors. On other other hand, the significance value of the current model was 0.658. Since the *p*-value was shown to be greater than 0.05, thus, suggesting that the data fitted the model.

For the classification accuracy, the model was found to correctly classify 65.8 percent of the overall cases of cognitive errors, in which it showed an improvement of 11.6 percent over the 54.2 percent in the null model.

From Table 4.12, the Wald statistic distinguished that frequency of usage – very frequently (Wald $x^2 = 16.768$, $p < 0.001$), frequency of usage – fairly often (Wald $x^2 = 9.647$, $p = 0.002$) and frequency of usage – on a few occasions (Wald $x^2 = 7.804$, $p = 0.005$) made unique statistically significant contributions to the model.

In addition, it was found that the more frequently a driver was to engage in mobile phone usage while driving, the more likely that he or she performed late and hard braking. When compared to 'once or twice' (reference category), the odds of committing this type of error was 7.493, 3.299 and 2.147 times more under each response category of 'very frequently', 'fairly often' and 'on a few occasions'.

The final logistic model for the likelihood of the cognitive errors, in terms of the occurrence of brake late and hard, can be formulated as follows:

$$\text{Logit } p \text{ (Cognitive Errors)} = -0.518 + 2.014 \text{ (very frequently)} + 1.193 \text{ (fairly often)} + 0.764 \text{ (on a few occasions)} \quad (4.6)$$

4.2.4.7 Texting: Action Errors (Fail to Indicate When Turning)

The results of logistic regression analysis in predicting the likelihood of action errors are summarised in Table 4.13.

Table 4.13: Logistic Regression Analysis in Predicting Likelihood of Action Errors

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Age Group			0.035	2	0.983	
< 25 (Reference Category)	0.000	0.000	0.000	0	-	-
25-64	-0.036	0.406	0.008	1	0.929	0.965
> 65	-0.285	1.546	0.034	1	0.854	0.752

Table 4.13 continued

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Gender						
Male	-0.048	0.266	0.033	1	0.856	0.953
Female (Reference Category)	0.000	0.000	0.000	0	-	-
Occupation			15.077	17	0.590	
Student (Reference Category)	0.000	0.000	0.000	0	-	-
Accounting/Finance	1.207	0.663	3.312	1	0.069	3.345
Admin/Human Resources	1.008	0.564	3.192	1	0.074	2.741
Arts/Media/ Communications	0.134	0.547	0.060	1	0.806	1.144
Building/Construction	0.120	0.650	0.034	1	0.854	1.127
Computer/Information Technology	1.099	.813	1.825	1	0.177	3.000
Driver	1.375	1.379	0.995	1	0.319	3.957
Education/Training	1.437	0.752	3.652	1	0.056	4.210
Engineering	1.080	0.597	3.271	1	0.070	2.946
Healthcare	0.667	0.581	1.318	1	0.251	1.949
Homemaker/Housewife	0.838	0.840	0.995	1	0.318	2.312
Hotel/Restaurant	-0.339	0.917	0.137	1	0.711	0.712
Manufacturing	0.752	0.781	0.927	1	0.336	2.121
Retiree	1.754	1.684	1.085	1	0.298	5.775
Sales/Marketing	**1.314**	**0.527**	**6.223**	**1**	**0.013***	**3.720**
Sciences	0.177	0.921	0.037	1	0.848	1.194
Self-employed	0.555	0.731	0.577	1	0.448	1.742
Services	0.841	0.558	2.272	1	0.132	2.319
Driving Experience	-0.021	0.014	2.321	1	0.128	0.979
Frequency_of_Usage			0.709	3	0.871	
Once or Twice (Reference Category)	0.000	0.000	0.000	0	-	-
On a Few Occasions	-0.072	0.268	0.072	1	0.789	0.931

Table 4.13 continued

Predictor	β	*SE* β	Wald's x^2	*df*	*p*	e^{β}
Fairly Often	-0.070	0.377	0.034	1	0.853	0.933
Very Frequently	0.279	0.438	0.404	1	0.525	1.321
Traffic_Conditions			15.014	2	0.001	
Stopping at a Traffic Light (Reference Category)	0.000	0.000	0.000	0	-	-
Driving on a Straight Road	**1.578**	**0.448**	**12.418**	**1**	**0.000****	**4.843**
Slow-moving Traffic	**0.602**	**0.261**	**5.306**	**1**	**0.021***	**1.826**
Constant	-0.644	0.301	4.587	1	0.032	0.525

N = 365; Cox and Snell $R^2 = 0.124$; Nagelkerke $R^2 = 0.165$; *$p < 0.05$; **$p < 0.01$

The full model was statistically significant χ^2 (26, N = 365) = 48.233, $p = 0.005$, indicating that the sets of independent variables improved the predictive power of the model.

Besides, it can also be concluded that the model as a whole was able to explain roughly 12.4 percent (Cox & Snell R Square) and 16.5 percent (Nagelkerke R Square) of the variation in predicting the likelihood of committing action errors. The significance value of the full model was also greater than 0.05 ($p = 0.968$), therefore supporting for the model fit. When compared with the null model, the full model correctly classified 66.3 percent of the overall cases of action errors, which showed an improvement of 15.9 percent.

The Wald criterion demonstrated that traffic conditions – driving on a straight road (Wald $x^2 = 12.418$, $p < 0.001$), occupation – sales/marketing (Wald $x^2 = 6.223$, $p = 0.013$) and traffic conditions – slow-moving traffic (Wald $x^2 = 5.306$, $p = 0.021$) were the significant predictor variables in predicting the likelihood of committing action errors. Other variables were not statistically significant to the model.

The strongest predictor of committing action errors was driving on a straight road, recorded an odds ratio of 4.843. In other words, drivers who found to engage in mobile phone use while driving on a straight road, as compared to when stopping at a traffic light (reference group), were more likely that they committed action errors. For every increase in texting while driving, the odds of committing such error increased by 4.843 times, with all other factors in the model being equal.

In terms of the occupation, respondents working in the sales or marketing industry were 3.720 times more likely to commit this error than that of student (reference group). In contrast, the odds ratio of 1.826 indicated that the tendency of having a failure in indicate when turning increased by 1.826 times for those who reported using a mobile phone when the traffic flow is slow.

The logistic model for the likelihood of action errors occurring can be written as follows:

$$\text{Logit } p \text{ (Action Errors)} = -0.644 + 1.578 \text{ (driving on a straight road)} + 1.314 \text{ (sales/marketing)} + 0.602 \text{ (slow-moving traffic)} \tag{4.7}$$

4.3 Discussion

The effects of age, gender, occupation, driving experience, frequency of usage and traffic conditions on different types of driving errors under different mobile phone behaviours were thoroughly examined in the previous section and the summary of model estimates are depicted in Table 4.14 and Table 4.15, based on their respective odds ratio.

Table 4.14: Summary of the Logistic Regression Models (Phone Call)

	Road Violations (Red Light Running)	**Cognitive Errors (Lane Excursions)**	**Action Errors (Fail to Indicate When Turning)**
Significant Variables	Frequency of Usage- Very Frequently	Occupation – Accounting/Finance	Occupation – Arts/Media/Communication
	Occupation – Sales/Marketing	Occupation – Building/Construction	Traffic Conditions - Driving on a straight road
	Traffic Conditions – Driving on a straight road	Driving Experience	Traffic Conditions – Slow-moving traffic
			Driving Experience

Table 4.15: Summary of the Logistic Regression Models (Texting)

	Road Violations (Red Light Running)	**Cognitive Errors (Lane Excursions)**	**Cognitive Errors (Brake Late and Hard)**	**Action Errors (Fail to Indicate When Turning)**
Significant Variables	Frequency of Usage - Very Frequently	Frequency of Usage - Very Frequently	Frequency of Usage - Very Frequently	Traffic Conditions – Driving on a Straight Road
	Traffic Conditions – Driving on a Straight Road	Frequency of Usage - Fairly Often	Frequency of Usage - Fairly Often	Occupation – Sales/Marketing
	Occupation – Sales/Marketing	Frequency of Usage - On a Few Occasions	Frequency of Usage - On a Few Occasions	Traffic Conditions – Slow-moving Traffic
	Frequency of Usage - Fairly Often	Driving Experience		
	Frequency of Usage - On a Few Occasions			
	Driving Experience			

4.3.1 Age and Driving Experience

Surprisingly, the explanatory variable of age groups (young, middle-aged and old), as a whole, was not statistically significant to the three driving errors made, regardless of phone calls or texting. This might due to the fact that the effect of this parameter was very weak as compared to other variables in the current study. Although the past literature (e.g., Li et al., 2014; Papantoniou, 2015; Tractinsky et al., 2013) inferred that older drivers were more prone to mobile phone distractions and commit driving errors, it is, however, in good agreement with the findings of Sun and Jia (2016) which have shown that the age and driving experience effects did not significantly predict the self-reported errors made while engaging in mobile phone, such as a failure to yield or stop and perform sudden brake to avoid a crash. Interesting too, is that, when the authors examined the mobile phone-related crashes, the logistic regression model demonstrated higher odds among the young and novice drivers.

On the other hand, driving experience showed a significant negative relationship with the likelihood of committing errors, not only during the phone call, but texting while driving. In other words, the more experienced drivers reported that they have engaged in mobile phone usage while driving, the less likely that they experienced driving errors. Of the errors made during the phone call, it was shown that driving experience predicted cognitive errors (lane excursions) and action errors (fail to indicate when turning). With respect to texting, the effects on the road violations (red light running) and cognitive errors (lane excursions) were notable. The results of the current investigation highlighted that novice, inexperienced drivers were more vulnerable to the distracting effects, in terms of the cognitive demands of mobile phone while driving. The resulting impacts can likely be explained by the lack of ability and driving skills of the inexperienced drivers in controlling their vehicles. This is, however, contrary to Precht et al.'s (2017) findings, that driving experience was not related to errors and violations.

4.3.2 Gender

Other than the age groups, the final results also indicated that gender did not yield any significant outcome in contributing to the probability of all three errors committed, whether during phone conversations or text messages while driving. In general, the present finding agreed relatively well with that from Poysti et al. (2005). The authors suggested that gender differences did not have an influence on the hazards experienced when mobile phones were used while driving. This is, however, contradictory from a number of past studies (e.g., Hancock et al., 2003; Lesch & Hancock, 2004) which mentioned that the effects of mobile phone use while driving on female drivers were much greater than male drivers. From what was found by Papantoniou (2015), he concluded that there was a positive relationship between female drivers and driving errors. Also, the results of a later study by Sun and Jia (2016) demonstrated a similar pattern, whereby female drivers were two times more likely to experience significant safety hazards than male drivers when engaged with their mobile phones while driving.

4.3.3 Occupation

One aspect which was less discovered while conducting the literature review is to take into account the occupation of the respondents. As observed from the developed regression models, occupation variable has a considerable influence on the probability of all three categories of road violations, cognitive errors and action errors under mobile phone conversations. When a driver texts and drives, this explanatory variable was found to have a significant effect on the errors made, except for the occurrence of cognitive errors, in terms of lane excursions, as well as brake late and hard. As evidenced, not all occupations have significant effects on the response variables. In simpler term, it is inferred that those required to use mobile phone more often for work purposes were susceptible to commit the said errors. For example, those working in the sales/marketing industry. It is predicted that the drivers from this group has a higher likelihood of reporting to have performed road violations when they drive and engage in mobile phone usage simultaneously, regardless of initiating or answering phone calls or texting. Also, they are more likely to commit action errors, which in this case is the failure to indicate when turning, under texting while driving condition. In contrast, Poysti et al. (2005) found significant differences, suggesting that mobile phone-related hazards were associated with a prestige job or a person with a higher level position in his or her career, such as manager or executive.

4.3.4 Frequency of Usage

On top of that, it is apparent from the tables that three categories of frequency of mobile phone usage (on a few occasions, fairly often and very frequently) were statistically significant predictors of the errors resulted from texting while driving, except for action errors (fail to indicate when turning). These were, road violations (red light running), cognitive errors (lane excursions), cognitive errors (brake late and hard). Interesting too, is that, Harrison (2011) also found that texting resulted into driver swaying into other lanes. For phone call, the occurrence of road violations, was predicted by only one group of frequency (very frequently).

Hence, based on the results, it can be inferred that frequency of usage is significantly associated with driving errors, regardless of the types of mobile phone activities and types of errors made. This is consistent with the literature (Hamilton et al., 2013; Harrison, 2011; Sun & Jia, 2016). However, drivers who tend to text messages over engaging in mobile phone conversations while driving, generally have higher risks in committing all errors, as the impacts of the former were found to be higher than that of the latter.

4.3.5 Traffic Conditions

Another point of interest was regarding the traffic conditions at the time a driver is being distracted while driving (either talking on a mobile phone or texting). Similar to the results obtained by Atchley et al. (2011), the majority of drivers in this study admitted to be engaged in mobile phone use while stopping at a traffic light. As expected, the drivers who typically converse on mobile phones or text and drive on a straight road reported higher odds of committing road violations, more specifically, contravene the traffic signal control device when approaching intersection during or after the onset of yellow interval. This is probably caused by the higher speed while driving on a straight, low traffic condition, and the results were consistent with that found by Papantoniou (2015). As proven by the statistical models, this parameter was also found to predict the occurrence of action errors, in both mobile phone conditions.

Furthermore, it is worth noting that another traffic condition, slow-moving traffic had a significant effect with the increase probability of committing action errors. All these are probably explained by their full concentration on either the conversation or content of the text messages instead of the surrounding road environment and as a consequence they were more likely to fail to react during unexpected incidents.

4.4 Summary of Major Findings

In general, different statistical analyses have been carried out in the present chapter in order to examine the DDB associated with mobile phone usage. The following are the overview of the key findings which may contribute to the understanding of this study:

4.4.1 The Trend of DDB Associated With Mobile Phone Usage

- Overall, the mobile phone usage while driving is reported to be a common behaviour among the 624 drivers who took part in this study, although they realized the riskiness of such behaviour while driving (M = 8.59, SD = 1.897). In spite of the prior evidence, only 11% (n = 68) of them claimed that they have been distracted and consequently, involved in road traffic crashes.
- More than 70% of respondents reported that they ‘once or twice’ (36.5%) or ‘on a few occasions’ (36.4%) used the mobile phone while driving, whereas 27.1% of them reported that they ‘fairly often’ and ‘very frequently’ to be engaged in mobile phones when driving.
- Considering the underlying reasons of using a mobile phone while driving, it can be concluded that both work and non-work related (41.3%) dominated the highest, followed by work-related (31.9%) and lastly, non-work related (26.8%).
- It is also observed that most of the respondents (57.9%) reported that they were more likely to engage in mobile phones when stopping at a traffic light, as well as during slow-moving traffic (28.2%). Only 13.9% of respondents admitted that they tend to have phone conversations or texting when driving on a straight road.

4.4.2 Impacts of DDB Associated With Mobile Phone Usage on Driving Errors

- In terms of the specific categories of driving errors, DDB associated with mobile phone usage was identified to significantly affect road violations, cognitive errors and action errors, under two different mobile phone scenarios.
- The underlying driving errors associated with phone calls while driving were red light running (M = 5.10, SD = 2.674), fail to indicate when turning (M = 5.03, SD = 2.512) and lane excursions (M = 5.00, SD = 2.537).
- Texting while driving, on the other hand, has led to errors such as brake late and hard (M = 6.19, SD = 3.042), lane excursions (M = 6.13, SD = 2.686), red light running (M = 5.15, SD = 2.823) and fail to indicate when turning (M = 5.08, SD = 2.825).

4.4.3 Other Factors Affecting Different Types of Driving Errors (RV, CE & AE)

4.4.3.1 Phone Call

- <u>Road Violations (Red Light Running)</u>

  The findings revealed that frequency of usage (very frequently, e^{β} = 3.631), occupation (sales/marketing, e^{β} = 3.244) and traffic conditions (driving on a straight road, e^{β} = 2.695), ranked from the highest to lowest in terms of odds ratios, were among the significant predictors which increase the likelihood of drivers committing road violations.

- <u>Cognitive Errors (Lane Excursions)</u>

  The parameters found significant in predicting the cognitive error model were the occupation of drivers (accounting/finance, e^{β} = 7.864; building/construction, e^{β} = 5.360) and driving experience (e^{β} = 0.930). As expected, drivers with less driving experience were more likely to commit cognitive errors.

- Action Errors (Fail to Indicate When Turning)

  The occupation (arts/media/communications, $e^{\beta} = 5.215$), traffic conditions (driving on a straight road, $e^{\beta} = 2.791$; slow-moving traffic, $e^{\beta} = 2.017$) and driving experience ($e^{\beta} = 0.965$) were among the four predictors of action error. The results indicated that between a student and a person's career in arts/media/communications, the latter had a bigger impact on the probability of performing such error, especially when they were driving on a straight road and during slow-moving traffic. An increase in the case of phone call while driving among the drivers of lesser experience led to an increase in such error.

4.4.3.2 Texting

- Road Violations (Red Light Running)

  Based on the logistic regression model, the frequency of usage (very frequently, $e^{\beta} = 3.590$), traffic conditions (driving on a straight road, $e^{\beta} = 2.998$), occupation (sales/marketing, $e^{\beta} = 2.964$) and frequency of usage (fairly often, $e^{\beta} = 2.148$; on a few occasions, $e^{\beta} = 1.902$) were found to increase the probability of committing road violations when the drivers reported to text and drive. Besides, driving experience ($e^{\beta} = 0.965$) was also found to be the significant predictor, indicating that the incident of road violations is likely to be reduced when those reported to have engaged in texting while driving have more driving experience.

- Cognitive Errors (Lane Excursions)

  Similarly, the frequency of usage, in terms of (very frequently, $e^{\beta} = 2.488$; fairly often, $e^{\beta} = 2.372$; on a few occasions, $e^{\beta} = 1.852$) significantly predicted the likelihood of committing cognitive errors. Also, driving experience (e^{β} = 0.959) had a significant negative effect on such errors.

- Cognitive Errors (Brake Late and Hard)

  The results indicated that frequency of usage (very frequently, e^{β} = 7.493; fairly often, e^{β} = 3.299; on a few occasions, e^{β} = 2.147) was associated with an increase in cognitive error, in terms of braking late and hard.

- Action Errors (Fail to Indicate When Turning)

  Finally, traffic conditions, without regard to driving on a straight road (e^{β} = 4.843) and slow-moving traffic (e^{β} = 1.826), were shown to predict the probability of action error. Such error increased with both traffic conditions, as well as those from the sales/marketing industry (e^{β} = 3.720).

4.5 Validation of Binary Logistic Regression Models

The final and critical stage involves the validation of the results, in which the procedures have already been outlined at length in Chapter 3. The data splitting approach was used to divide the data set into analysis and holdout (validation) sample in a ratio of 60:40. In order to assess the external validity of binary logistic regression models, holdout sample was used. The overall percentage correctly classified (hit ratio) obtained from the classification matrix in each sample is evaluated. The comparison of hit ratio with the standard, namely the proportion chance criterion was then carried out for every model.

4.5.1 Classification Table

4.5.1.1 Phone Call: Road Violations (Red Light Running)

The classification table which consists of analysis and holdout sample is presented in Table 4.16.

Table 4.16: Classification Table of Road Violations (Phone Call)

Observed			Predicted							
			Analysis Sample				Holdout (Validation) Sample			
			Red Light Running			Percentage Correct	Red Light Running			Percentage Correct
			No	Yes	Total		No	Yes	Total	
Step 0	Red Light Running	No	119	56	175	68.0	62	48	110	56.4
		Yes	64	126	190	66.3	29	120	149	80.5
Overall Percentage						**67.1**				**70.3**

As seen from the table above, the analysis sample correctly classified the outcome for 67.1 percent, whilst holdout sample had a correct classification of 70.3 percent. Hence, to check whether or not the hit ratios for both samples exceed the proportional chance criterion, the calculation is illustrated as follows:

$$C_{PRO} = p^2 + (1 - p)^2$$

$$= (\frac{175+110}{624})^2 + (1 - \frac{175+110}{624})^2$$

= 0.504 × 100% × 1.25

= 63.0%

The overall hit ratios surpassed the proportional chance criterion (50.4 percent), as well as the suggested threshold value (comparison standard plus 25 percent) for this criterion (63.0 percent), indicating that the validity of the model has been achieved.

4.5.1.2 Phone Call: Cognitive Errors (Lane Excursions)

Table 4.17 provides the classification of individual cases for both analysis and holdout sample.

Table 4.17: Classification Table of Cognitve Errors (Phone Call)

Observed			Predicted							
			Analysis Sample				Holdout (Validation) Sample			
			Lane Excursions			Percentage Correct	Lane Excursions			Percentage Correct
			No	Yes	Total		No	Yes	Total	
Step 0	Lane Excursions	No	90	70	160	56.3	109	28	137	79.6
		Yes	40	165	205	80.5	51	71	122	58.2
	Overall Percentage					**69.9**				**69.5**

The results from Table 4.17 have shown that the hit ratio for the analysis sample recorded a value of 69.9 percent, and that the holdout sample was 69.5 percent. For the proportional chance criterion, the computation of the threshold value is as follows:

$C_{PRO} = p^2 + (1 - p)^2$

$= (\frac{160+137}{624})^2 + (1 - \frac{160+137}{624})^2$

$= 0.501 \times 100\% \times 1.25$

$= 62.6\%$

The hit ratios of analysis and holdout samples were greater than the threshold value of the proportional chance criterion, which in this case is 62.6 percent. Hence, it is evident that the model was valid as both samples have achieved acceptable levels of classification accuracy.

4.5.1.3 Phone Call: Action Errors (Fail to Indicate When Turning)

The information provided in Table 4.18 summarises the classification accuracy of the analysis and holdout sample, with the following results:

Table 4.18: Classification Table of Action Errors (Phone Call)

Observed			Predicted							
			Analysis Sample				Holdout (Validation) Sample			
			Fail to Indicate When Turning			Percentage Correct	Fail to Indicate When Turning			Percentage Correct
			No	Yes	Total		No	Yes	Total	
Step 0	Fail to Indicate When Turning	No	38	79	117	32.5	27	50	77	35.1
		Yes	25	223	248	89.9	16	166	182	91.2
Overall Percentage						**71.5**				**74.5**

Based on the data, it can be seen that the percentage accuracy in classification increased from 71.5 percent (analysis sample) to 74.5 percent (holdout sample). Both these hit ratios were then compared with the proportional chance criterion, which can be calculated as follows:

$$C_{PRO} = p^2 + (1 - p)^2$$

$$= (\frac{117+77}{624})^2 + (1 - \frac{117+77}{624})^2$$

$$= 0.571 \times 100\% \times 1.25$$

$$= 71.4\%$$

The suggested threshold value of proportional chance criterion (71.4 percent) was found lower than the classification accuracy of analysis and holdout samples. The hit ratios of both samples deduced that a good model validity has been achieved.

4.5.1.4 Texting: Road Violations (Red Light Running)

The analysis of road violations model under texting condition is again through the examination of percentage accuracy in classification, and the results are indicated in Table 4.19.

Table 4.19: Classification Table of Road Violations (Texting)

Observed			Predicted							
			Analysis Sample				Holdout (Validation) Sample			
			Red Light Running			Percentage Correct	Red Light Running			Percentage Correct
			No	Yes	Total		No	Yes	Total	
Step 0	Red Light Running	No	91	73	164	55.5	60	41	101	59.4
		Yes	56	145	201	72.1	35	123	158	77.8
Overall Percentage						**64.7**				**70.7**

It is apparent that the overall percentage accuracy in classification of analysis and holdout sample were 64.7 percent and 70.7 percent, respectively. The calculation for the proportion chance criterion is expressed as follows:

$$C_{PRO} = p^2 + (1 - p)^2$$

$$= (\frac{164+101}{624})^2 + (1 - \frac{164+101}{624})^2$$

= 0.511 × 100% × 1.25

= 63.9%

The hit ratios of the analysis and the holdout sample have been found to exceed the proportional chance criterion (63.9 percent), which was deemed acceptable in terms of model validation.

4.5.1.5 Texting: Cognitive Errors (Lane Excursions)

Table 4.20 presents the percentage correctly classified of individual cases for analysis and holdout sample.

Table 4.20: Classification Table of Cognitive Errors (Texting)

Observed			Predicted							
			Analysis Sample				Holdout (Validation) Sample			
			Lane Excursions			Percentage Correct	Lane Excursions			Percentage Correct
			No	Yes	Total		No	Yes	Total	
Step 0	Lane Excursions	No	70	74	144	48.6	52	47	99	52.5
		Yes	39	182	221	82.4	27	133	160	83.1
Overall Percentage						**69.0**				**71.4**

The analysis sample had a correct classification of 71.4 percent, compared with 69.0 percent of the holdout sample, which is as evident in Table 4.20. The proportion chance criterion was then calculated based on the formula below:

$$C_{PRO} = p^2 + (1 - p)^2$$

$$= [(\frac{144+99}{624})^2 + (1 - \frac{144+99}{624})^2]$$

$$= 0.525 \times 100\% \times 1.25$$

$$= 65.6\%$$

The analysis and holdout samples recorded greater hit ratio values than the proportional chance criterion (65.6 percent), which signifies that the model validity is sufficient.

4.5.1.6 Texting: Cognitive Errors (Brake Late and Hard)

The classification results of both analysis and holdout samples are shown in Table 4.21. The interpretation of the classification of individual cases indicates the following:

Table 4.21: Classification Table of Cognitive Errors (Texting)

Observed			Predicted							
			Analysis Sample				Holdout (Validation) Sample			
			Brake Late and Hard			Percentage Correct	Brake Late and Hard			Percentage Correct
			No	Yes	Total		No	Yes	Total	
Step 0	Brake Late and Hard	No	93	74	167	55.7	78	41	119	65.5
		Yes	51	147	198	74.2	34	106	140	75.7
Overall Percentage						**65.8**				**71.0**

In the analysis sample, the hit ratio scored 65.8 percent, and it increased to 71.0 percent in the holdout sample. Moving into the proportional chance criterion, the calculation of the threshold value can be computed as follows:

$C_{PRO} = p^2 + (1 - p)^2$

$= [(\frac{167+119}{624})^2 + (1 - \frac{167+119}{624})^2]$

$= 0.504 \times 100\% \times 1.25$

$= 62.9\%$

As observed, the analysis and holdout samples hit ratios were greater than the proportional chance criterion (62.9 percent). Thus, it can be inferred that model validity has been satisfied.

4.5.1.7 Texting: Action Errors (Fail to Indicate When Turning)

The section labelled "Classification Table" in Table 4.22 yields the percentage of the cases in action errors.

Table 4.22: Classification Table of Action Errors (Texting)

Observed			Predicted							
			Analysis Sample				Holdout (Validation) Sample			
			Fail to Indicate When Turning			Percentage Correct	Fail to Indicate When Turning			Percentage Correct
			No	Yes	Total		No	Yes	Total	
Step 0	Fail to Indicate When Turning	No	129	52	181	71.3	88	40	128	68.8
		Yes	71	113	184	61.4	37	94	131	71.8
	Overall Percentage					**66.3**				**70.3**

In the analysis sample, the percentage of correctly classified cases of action errors were 66.3 percent. Holdout sample, on the other hand, recorded 70.3 percent of cases overall. These percentages were then compared with the proportional chance and the maximum chance criterion, which can be calculated as follows:

$C_{PRO} = p^2 + (1 - p)^2$

$= [(\frac{181+128}{624})^2 + (1 - \frac{181+128}{624})^2]$

$= 0.50 \times 100\% \times 1.25$

$= 62.5\%$

The threshold value was 62.5 percent for the proportional chance criterion. Since the hit ratios for both samples exceeded the threshold value, it can be concluded that the classification results as displayed in Table 4.22 provide support for model validity.

4.5.2 Summary

Generally, the logistic regression models of road violations, cognitive errors and action errors for both phone call and texting while driving, have been found to demonstrate sufficient external validity. This has been proven through the hit ratio values of all holdout models which exceeded the value of proportional chance criterion.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

Chapter five addresses the summary of the study conducted. The significant findings, research limitations and the beneficial implications to the development of road safety are discussed. Apart from that, appropriate recommendations are proposed based on the study limitations for the improvement of future research.

5.1 Summary

The use of mobile phone while driving is a growing trend and has become a major concern due to the disastrous effects on driving. In fact, the relationship between mobile phone usage and driving errors have been studied extensively, but the knowledge of the impacts on the different category of driving errors is still found lacking, and that it is crucial for an in-depth understanding of this risky behaviour. Hence, the present study set out to determine the likelihood of driving errors due to DDB associated with mobile phone usage.

5.2 Significant Findings

Pertaining to the research questions, analysis of the computed results was summarised as below:

RQ1. From the investigation, mobile phone usage while driving has generally been found to be a common behaviour among the drivers in Malaysia. It is obvious that they realised the resulting hazards and risks, as the majority of them was found to reduce the frequency of usage while driving. The descriptive statistics showed that those in the ‘once or twice’ and ‘on a few occasions’ categories constituted more than 70% of the overall respondents, compared with only 27.1% of those in the ‘fairly often’ and ‘very frequently’ category. When asked on the reasons of using mobile phones while driving, both work and non-work related (41.3%) exemplified the highest proportion, and slightly more than a quarter (26.8%) admitted to have used the mobile phone solely for personal or social (non-work related) while driving. Besides, it is found that drivers were more likely to use a mobile phone when the vehicle is static, which is when they stopped at a traffic light (57.9%). However, approximately 13.9% of drivers chose to disregard the danger, as they admitted to have engaged in mobile phone usage while driving on a straight road and another 28.2% during the slow-moving traffic. It is also worth noting that the low number of road traffic crashes (11%) resulted from the distractions of mobile phone usage is probably the main reason which has prompted the increase in such behaviour.

RQ2. This research revealed that the use of mobile phone while driving, without regard of phone calls or texting, had a significant impact on road violations, cognitive errors and action errors. In terms of the underlying errors in each error category, phone conversations were more likely to result in red light running (M = 5.10, SD = 2.674), fail to indicate when turning (M = 5.03, SD = 2.512) and lane excursions (M = 5.00, SD = 2.537). Interestingly, errors such as brake late and hard (M = 6.19, SD = 3.042), lane excursions (M = 6.13, SD = 2.686), red light running (M = 5.15, SD = 2.823) and fail to indicate when turning (M = 5.08, SD = 2.825) were associated with the consequences of texting while driving.

RQ3. Based upon the errors identified in RQ2, the results of the binary logistic regression models revealed the following:

- **Phone Call**

  1. Road violation (red light running) was associated with frequency of usage (very frequently, $e^{\beta}= 3.631$), occupation (sales/marketing, $e^{\beta}= 3.244$) and traffic conditions (driving on a straight road, $e^{\beta} = 2.695$).
  2. Cognitive error (lane excursions) was associated with occupation (accounting/finance, $e^{\beta} = 7.864$), occupation (building/construction, $e^{\beta} = 5.360$) and driving experience ($e^{\beta} = 0.930$).
  3. Action error (fail to indicate when turning) was associated with occupation (arts/media/communications, $e^{\beta}= 5.215$), traffic conditions (driving on a straight road, $e^{\beta}= 2.791$), traffic conditions (slow-moving traffic, $e^{\beta} = 2.017$) and driving experience ($e^{\beta} = 0.965$).

- **Texting**

  1. Road violation (red light running) was associated with frequency of usage (very frequently, $e^{\beta} = 3.590$), traffic conditions (driving on a straight road, $e^{\beta} = 2.998$), occupation (sales/marketing, $e^{\beta} = 2.964$), frequency of usage (fairly often, $e^{\beta} = 2.148$; on a few occasions, $e^{\beta} = 1.902$) and driving experience ($e^{\beta} = 0.965$).
  2. Cognitive error (lane excursions) was associated with frequency of usage (very frequently, $e^{\beta} = 2.488$; fairly often, $e^{\beta} = 2.372$; on a few occasions, $e^{\beta} = 1.852$) and driving experience ($e^{\beta} = 0.959$).

3. Cognitive error (brake late and hard) was associated with frequency of usage (very frequently, $e^{\beta} = 7.493$; fairly often, $e^{\beta} = 3.299$; on a few occasions, $e^{\beta} = 2.147$).
4. Action error (fail to indicate when turning) was associated with traffic conditions (driving on a straight road, $e^{\beta} = 4.843$), occupation (sales/marketing, $e^{\beta} = 3.720$) and traffic conditions (slow-moving traffic, $e^{\beta} = 1.826$).

The evidence from this study is thought to make noteworthy contributions in terms of road safety research. These findings have gone some way towards enhancing our understanding of the relationships of different types of mobile phone behaviours on different category of driving errors. Also, the contributing factors in predicting those errors were highlighted. In short, it can be concluded that the three main research objectives, in relation to the research questions have been successfully attained.

5.3 Implications of Research

The analysis of DDB associated with mobile phone usage impacts on driving errors in this research ought to be highlighted as it is beneficial to the government who intend to use data-driven solutions to significantly reduce the road crashes resulted from DDB. The findings of this study are extremely insightful to the traffic agencies like the MIROS, JKJR and even JPJ teams in enhancing the understanding of the trend of mobile phone behaviours among the Malaysian drivers. Also, the outcomes will help the said parties, especially JPJ to identify, prioritise appropriate legislation and enforcement strategies in reducing the resulting impacts from the DDB associated with mobile phone usage. This would then eliminate the risks and lead to a safer road environment for the vulnerable road users in Malaysia.

In terms of academics, this research is thought to be crucial as the current findings add to a growing body of literature which contribute to the knowledge base of the field of road safety, particularly in the context of Malaysia. Besides, the evidence from this study serves as a base future research in the related areas.

5.4 Study Limitations

Several practical limitations were encountered while undertaking this research, which nevertheless offer perspectives for future studies. Although remuneration was to be paid upon the completion of the questionnaire, many respondents were not willing to participate. This is especially obvious when the data collection was performed in Kuala Lumpur. Since this study was solely based on the questionnaire in obtaining the information from the respondents, it was extremely difficult for the researcher to cover a large number of respondents, given constraints on time, budget and location. As such, it can be observed that there were low number of respondents from the mentioned location, which could not really represent the population of interest equally.

Another issue which the researcher could not avoid is the possibility of under-reporting from the respondents. As the survey questionnaire was done through face-to-face approach, whereby each question was clarified before answering by the respondents. However, some may not be comfortable with such approach, which resulted in the answers given were not representing their actual mobile phone behaviours. Consequently, the final results were inflated.

5.5 Recommendations for Future Research

From this research, it is identified that the topic discussed can be explored on a larger scale. More information on the parameters of DDB associated with mobile phone usage would help to establish a greater degree of accuracy on this matter. If the debate is to be moved forward, a better understanding of the impacts of different mobile phone usage while driving on the likelihood of crash injury severity needs to be further developed. An alternative solution would be the long-term collaboration with the experts from the MIROS team and the Royal Malaysia Police (RMP) to re-evaluate the standardised traffic incident report form (POL27). A detailed section with information on the use of mobile phone at the time of a crash, such as the types of mobile phone activities perform by a driver (whether to initiate, answer a phone call or initiate, reply to, read a text), location (urban or rural area), weather (good or adverse weather) and road surface condition (dry or wet), as well as the injury severity (minor, severe or fatal) could be included in the POL27 form, and mandatory to be filled pertaining to cases of mobile phone-related crashes while driving. This is in fact crucial as the crash details could be retrieved easily, which will help to facilitate the analysis. The police officers, on the other hand, must be well-trained in the records management to avoid the lost of valuable information while collecting the data. Not only that, it is hoped that the RMP will be able to disclose the national crash historical data to the researchers in the future, so that an in-depth study of road traffic crashes associated with DDB can be conducted effectively and efficiently.

Besides, it is recommended that the impacts of DDB associated with mobile phone usage on driving errors to be undertaken using driving simulator in the future research. The underlying reason for using experimental investigation is that a range of driving errors can be identified accurately as some of the drivers might not realise that they have been committing the particular driving errors when engaging in mobile phone usage while driving. A set of questionnaire regarding the driving simulator experience would then be filled by the participants after the completion of driving simulator experiment, and comparing it with the results of the simulation study. This way, the belief that the research is reliable and valid would be enhanced. Although the identification of driving errors using simulator experiment has particularly been employed by other researchers (e.g., Papantoniou, 2015), it was found lacking in the Malaysian context, thereby providing insights for further investigation. This would also most likely to push the quality of the research to a higher level.

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APPENDICES

Appendix A

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

Appendix B

PARTICIPANT INFORMATION SHEET

Title: Modeling on the Likelihood of Driving Errors Due to Distracted Driving Behaviour (DDB) Associated with Mobile Phone Usage in Malaysia.

Invitation

You are invited to participate in a research study to assess how mobile phone usage (**Phone call and Texting**) while driving could influence the driving errors. The study is being conducted by Melissa Lee May Syn, from the Faculty of Engineering at Universiti Malaysia Sarawak. If you agree to take part in this research, you will be asked to complete the questionnaire which will take less than 10 minutes.

Voluntariness

Your participation in this research is voluntary. While we would be pleased to have you participate, we respect your right to decline to participate or discontinue participation. You may skip any particular question if you do not wish to answer at any time.

Risks and Benefits

There are no known risks if you participate in this study. The information you provide will be used to evaluate the impacts of mobile phone usage while driving on drivers' driving errors. The information collected may not benefit you directly, but it is crucial for the researcher to understand the rampant trend of this distracted driving behaviour. The insights gained from the research study could be used to prioritise safety measures so as to reduce road traffic crashes in Malaysia.

Confidentiality

This survey is anonymous. No one will be able to identify you or your answers, and no one will know whether or not you participated in this study. Only the researcher will have access to the information you provide except that as required by law. To make sure your participation is confidential, please do not provide any personally identifying information on the questionnaires. Should the data be published, no personal information will be disclosed.

Whom to Contact if I Require Further Information?

If you have any questions concerning the research study, please email kraduan@unimas.my or melissaleemaysyn@gmail.com.

Agreement

If you wish to participate in this study, please sign the attached consent form. A signature will indicate agreement to participate.

Thank you.

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CONSENT FORM

Statement of Consent

I have read and understand the above information, and I voluntarily participate in this research study. My signature below indicates my consent.

Participant Signature: ___________________

Date: __________________________

Section I: Respondents' Basic Demographic Information

Instruction: Kindly choose only one option unless otherwise stated.

1. **Age:** ________

2. **Gender:**
   - ☐ Male
   - ☐ Female

3. **Ethnicity:**
   - ☐ Malay
   - ☐ Chinese
   - ☐ Indian
   - ☐ Others (Please specify): ________

4. **Which of the following best describes your occupation?**
   - ☐ Accounting/Finance
   - ☐ Admin/Human Resource
   - ☐ Arts/Media/Communications
   - ☐ Building/Construction
   - ☐ Computer/Information Technology
   - ☐ Education/Training
   - ☐ Engineering
   - ☐ Healthcare
   - ☐ Hotel/Restaurant
   - ☐ Manufacturing
   - ☐ Sales/Marketing
   - ☐ Sciences
   - ☐ Services
   - ☐ Student
   - ☐ Others (Please specify): ________

5. **Driving Experience:** ________

Section II: Distracted Driving Behaviour (DDB) Associated with Mobile Phone Usage

Instruction: Kindly choose only one option unless otherwise stated.

NOTE: 'While Driving' does not necessarily mean that your vehicle must be moving. It includes when the vehicle stops at a traffic light, stops in congested traffic, etc.

6. **How often would you say you use a mobile phone while driving a vehicle?**
   - ☐ Once or twice
   - ☐ On a few occasions
   - ☐ Fairly often
   - ☐ Very frequently

7. **What is/are the purpose(s) of using a mobile phone while driving?**
   - ☐ Work-related
   - ☐ Non-work related (Personal/social)
   - ☐ All of the above

8. **Which of the following best describes the traffic condition where you have been using a mobile phone while driving a vehicle?**
   - ☐ Stopping at a traffic light
   - ☐ Driving on a straight road
   - ☐ Slow-moving traffic (e.g., Traffic congestion)

9. **On a scale from 1 to 10 with 10 being extremely risky, how risky do you feel that it is to use a mobile phone while driving a vehicle?**
   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **5** ☐ **6** ☐ **7** ☐ **8** ☐ **9** ☐ **10**

10. **Have you ever been involved in road traffic crashes as a result of the distractions caused by the use of mobile phone while driving?**
    - ☐ Yes
    - ☐ No

Section III: Impacts of Distracted Driving Behaviour (DDB) on Driving Errors

Instruction: The following are the items which relate the errors committed by drivers to each type of mobile phone usage (Phone Call and Texting) while driving. Kindly encircle the most relevant option for each of the items. You can mark your sincere response anywhere from 1 to 10; **Score 1** indicates **Not At All Likely**, while **Score 10** indicates **Extremely Likely**.

For example, for No.1. Exceed Speed Limit, based on my own driving experience, (a) Making or Receiving Phone Calls while driving has the biggest impact on driving over the speed limit, so I would rate it as 9, whilst (b) Texting while driving would be rated as 7.

11. (a) Making or Receiving Phone Call while Driving

No.	Items	Not at all likely									Extremely likely
1.	Exceed Speed Limit	1	2	3	4	5	6	7	8	9	10
2.	Red Light Running	1	2	3	4	5	6	7	8	9	10
3.	Misjudge Gap When Turning	1	2	3	4	5	6	7	8	9	10
4.	Travelling Too Fast for Turn	1	2	3	4	5	6	7	8	9	10
5.	Fail to See Pedestrian on Crossing	1	2	3	4	5	6	7	8	9	10
6.	Lane Excursions	1	2	3	4	5	6	7	8	9	10
7.	Brake Late and Hard	1	2	3	4	5	6	7	8	9	10
8.	Leave Indicator on After Turning Complete	1	2	3	4	5	6	7	8	9	10
9.	Assume An Action is Legal When Not	1	2	3	4	5	6	7	8	9	10
10.	Accelerate Too Fast	1	2	3	4	5	6	7	8	9	10
11.	Indicate Too Early Before a Turn	1	2	3	4	5	6	7	8	9	10
12.	Fail to Indicate When Turning	1	2	3	4	5	6	7	8	9	10
13.	Press Accelerator When Trying to Brake	1	2	3	4	5	6	7	8	9	10
14.	Following Too Close with Leading Vehicle	1	2	3	4	5	6	7	8	9	10

(b) Texting while Driving

No.	Items	Not at all likely									Extremely likely
1.	Exceed Speed Limit	1	2	3	4	5	6	7	8	9	10
2.	Red Light Running	1	2	3	4	5	6	7	8	9	10
3.	Misjudge Gap When Turning	1	2	3	4	5	6	7	8	9	10
4.	Travelling Too Fast for Turn	1	2	3	4	5	6	7	8	9	10
5.	Fail to See Pedestrian on Crossing	1	2	3	4	5	6	7	8	9	10
6.	Lane Excursions	1	2	3	4	5	6	7	8	9	10
7.	Brake Late and Hard	1	2	3	4	5	6	7	8	9	10
8.	Leave Indicator on After Turning Complete	1	2	3	4	5	6	7	8	9	10
9.	Assume An Action is Legal When Not	1	2	3	4	5	6	7	8	9	10
10.	Accelerate Too Fast	1	2	3	4	5	6	7	8	9	10
11.	Indicate Too Early Before a Turn	1	2	3	4	5	6	7	8	9	10
12.	Fail to Indicate When Turning	1	2	3	4	5	6	7	8	9	10
13.	Press Accelerator When Trying to Brake	1	2	3	4	5	6	7	8	9	10
14.	Following Too Close with Leading Vehicle	1	2	3	4	5	6	7	8	9	10

End of Survey

Thank you for your most valuable participation.