Analysis of crash and survey data to identify young drivers' distractions in Kansas

by

Ibrahim Alfallaj

B.S., Qassim University, Saudi Arabia, 2010
M.S., University of Dayton, 2014

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Civil Engineering
College of Engineering

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2018

Abstract

Young drivers are over-represented in crashes when compared to other age group drivers. Distracted driving is one of the major causes of traffic crashes by young drivers. The objective of this study was to assess the hazards of distracted driving among teenage (15–20 year old) and young-adult (21–26 year old) drivers in Kansas. This study used five years of crash data from the Kansas Crash and Analysis Reporting System (KCARS) database from 2011 to 2015. A multinomial logit modeling was used to identify the odds that a driver with a certain type of distraction would be involved in one of the three most common crash types: rear-end, angular, and single-vehicle crashes. Furthermore, ordered logistic modeling was used to analyze the crash data to identify the odds of more severe injuries for teenage and young-adult distracted drivers and their passengers involved in crashes. Survey data was used to develop a structural equation model (SEM) to define the relationship among young drivers' characteristics (e.g., participants' socioeconomic and demographic status), attitudes, and behaviors associated with distracted driving and cell phone use while driving.

Preliminary analysis showed that more than 12% of the total young drivers' crashes were distraction-affected crashes. According to the multinomial logit model results, most distraction types for teenage and young-adult drivers are related to rear-end or angular collisions. However, when distracted by cell phones at night, teenage drivers had a greater probability of being involved in single-vehicle crashes. In addition, when teenage drivers drove with their peers as front-seat passengers and were distracted in/on vehicle or by other electronic devices, they were more likely to be involved in single-vehicle crashes. Young-adult drivers distracted in/on vehicle or by cell phones under different conditions such as while driving old or sport utility vehicles, on curved roads, or at intersections, they were more likely to be involved in single-vehicle or

angular crashes. Whereas, when they were inattentive during the weekend, rear-end collisions were the most likely collision type.

According to the results of the ordered logistic model, teenage and young-adult drivers were more likely to be severely injured in cell phone-related crashes. More specifically, female teenage drivers had a greater probability of being severely injured than male teenage drivers when they were distracted by a cell phone, inside the vehicle, or were inattentive. Young-adult drivers that were distracted on road construction work zones by a cell phone or inside the vehicle, they and their passengers had a greater likelihood of sustaining a severe injury.

The SEM results revealed that teenage drivers are more prone than young-adult drivers to drive while distracted and are less likely to support the Kansas laws that ban cell phone use while driving. Also, the model results showed that young drivers who have been involved in crashes or near-crashes during the previous year are more likely to drive while distracted. These results indicate that distractions create threats to the lives of young Kansas drivers, their passengers, and other road users.

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Acknowledgements

First, I would like to thank Almighty God, who has helped and guided me to successfully complete my program of study.

I am very grateful to my principal advisor, Dr. Sunanda Dissanayake for her patience, encouragement, guidance and providing necessary support to complete this research. Special thanks extended to Dr. Robert Stokes, Dr. Eric Fitzsimmons, Dr. Margaret Rys, and Dr. Donald Saucier for serving as my doctoral committee members.

I would like to thank the Kansas Department of Transportation (KDOT) staff for their constant support with providing crash data. I also sincerely appreciate the presidents/advisors of the student organizations at Kansas State University, Fort Hays State University, and the University of Kansas for their help in collecting survey data. In addition, I gratefully thank Mr. Robert Gonzales who is the Drivers Education teacher and Dr. Stan Ward director of Teaching and Learning at Manhattan High School for their support in conducting surveys with their students. Heartfelt thanks to Cultural Mission of Royal Embassy of Saudi Arabia for providing me all possible financial assistance to complete my degree requirements.

Thanks extended to my friends and colleagues at Kansas State University who contributed in many different ways to the successful completion of this dissertation.

Finally, my sincere thanks go to my parents, Saleh and Latifa for their continued support, prayers, love, and contributions to completion of this research. I extended my sincere thanks to my wife Amjad for her prayers and continued support. I am grateful to my brothers and sisters for supporting me in taking this step.

Chapter 1 – Introduction

1.1 Background

Teenage and young-adult drivers are over-represented in motor vehicle crashes when compared to drivers in other age groups. In the United States, per 100,000 population, teenage and young-adult drivers had the highest fatality rate and the highest injury rate as compared to middle-aged, and older drivers [1]. In 2014, more than 1,700 teenage drivers (15 to 20 years old) were killed in traffic crashes, an increase of 1.0% from about 1,690 in 2013 [1]. There were more than 214 million licensed drivers in the United States in 2014. The number of licensed young drivers was 26.1 million (12.2% of total licensed drivers), a 4% decrease from 27.1 million licensed young drivers in 2007 [2]. In Kansas, in 2016 young drivers represented only 15.6% of total Kansas licensed drivers [2], but they were involved in 43.5% of all traffic crashes [3]. Distracted driving is one of the major causes of traffic crashes involving teenage and young-adult drivers. Distracted driving has recently become a serious issue not only to the lives of young drivers and their passengers, but also for other road users.

1.2 Definitions

Distracted driving can be defined as driving while doing another activity, such as eating, drinking, talking to passengers, adjusting car radio, and using cell phone for calling or texting, that takes driver's attention away from the road [4 and 5]. Another study defined distracted driving as secondary tasks that are unrelated to driving that occur either internal or external to the vehicle and that take the driver's attention away from the primary tasks of driving and responding to critical events [6]. Previous studies have identified three elements of driver distraction: visual, cognitive and manual [7, 8, and 9]. Visual distraction is defined as anything

that draws a driver's eyes off the primary tasks of driving; cognitive distraction is defined as anything that draws the driver's mental attention off the primary tasks of driving; and manual distraction is defined as anything that draws the driver's hands off the wheel. Most distractions often fit into more than one category. For instance, eating is visual and manual, whereas using cell phone for texting while driving is combination of all three categories of driver distraction.

1.3 Problem Statement

In 2014, distraction-affected crashes in the United States accounted for about 3,179 fatal crashes and 431,000 injury crashes [10]. According to the AAA Foundation for Traffic Safety (2013), 67% of United State drivers indicated that distracted driving was a main safety concern in 2012 compared to 2009, 2010, and 2011 [11]. Traffic safety facts from a five year period (2010 to 2014) from the National Highway Traffic Safety Administration (NHTSA) showed an annual average of 5,624,600 crashes, 901,000 distraction-affected crashes, and 59,400 crashes involving cell phone use in the United States [10]. During that five year period, distraction-affected crashes accounted for 16.0% of overall crashes, and crashes involving cell phone use accounted for 6.6% of total distraction-affected crashes. As shown in Figures 1.1 and 1.2, the total number of crashes, the number of distraction-affected crashes, and crashes involving cell phone use have increased by 645,000 (10.7%), 67,000 (7.0%), and 22,000 (31.9%), respectively, making distracted driving a serious highway safety problem.

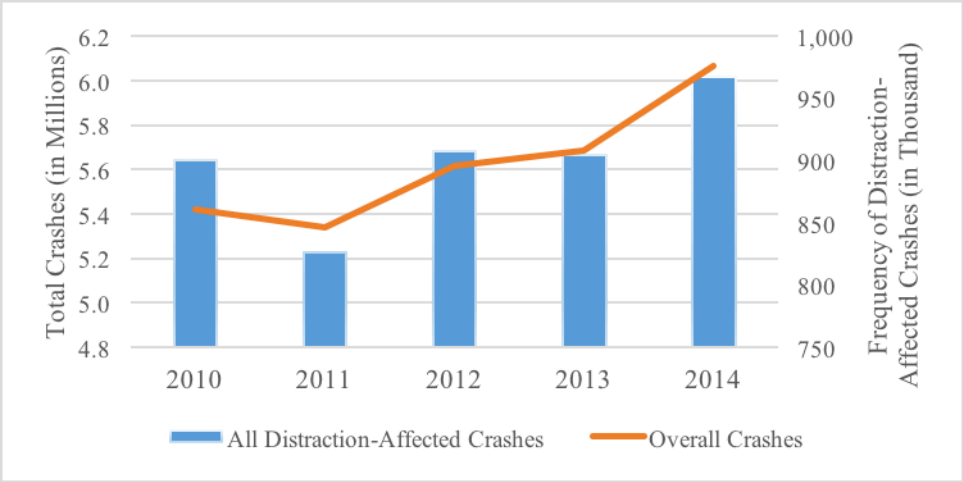


Figure 1.1 Overall Crashes and Distraction-Affected Crashes in the U.S. from 2010 to 2014 [10]

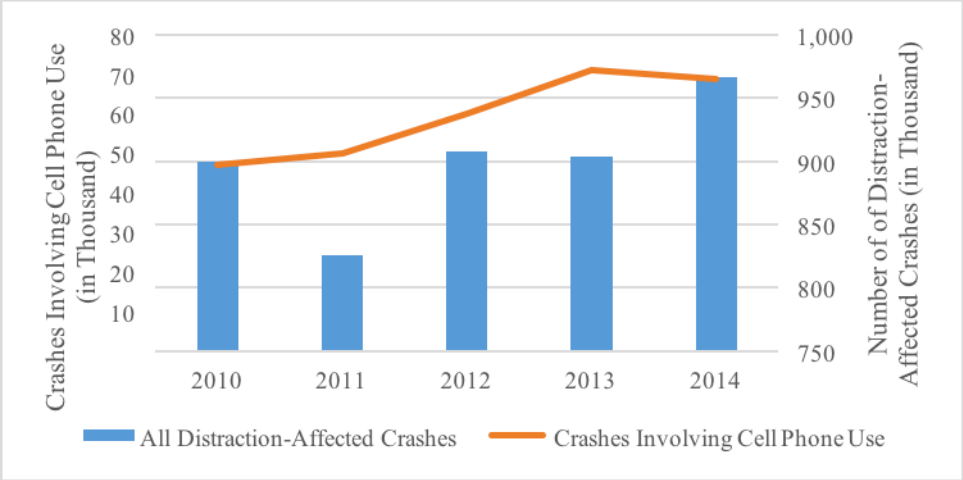


Figure 1.2 Distraction-Affected Crashes in the U.S. from 2010 to 2014 [10]

In 2014, 15 to 29 year-old drivers were involved in 39% of total fatal distraction-affected crashes [10]. Figure 1.3 illustrates the percent distribution of total drivers, distracted drivers and cell phone users involved in fatal crashes and shows that drivers under 30 years old had the highest rate of fatal crashes when compared with other age groups. Further, for drivers who are under 30 years old, the main concerns are distracted driving and cell phone use while driving.

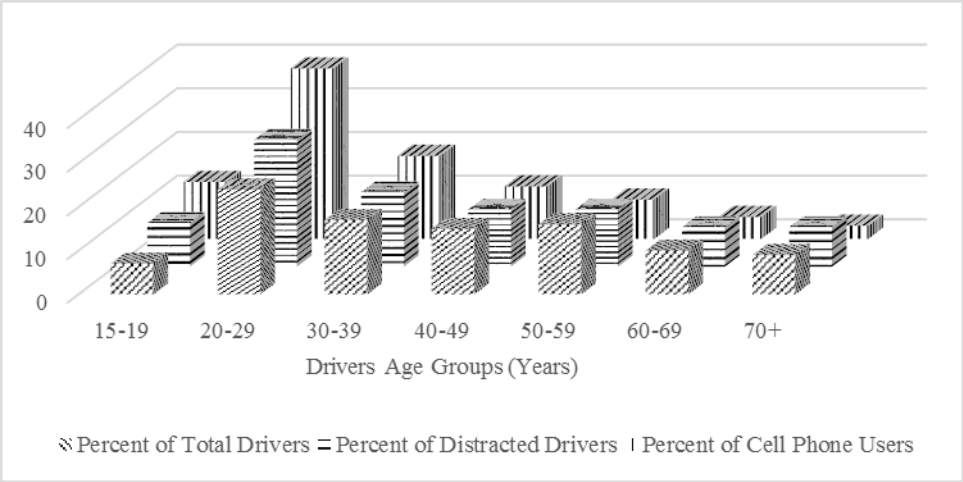


Figure 1.3 Percent Distribution of Total Drivers, Distracted Drivers, and Cell Phone Users Involved in Fatal Crashes in the U.S. in 2014 [10]

In Kansas, in 2016, there were 633 crashes where cell phones were used while driving, 218 crashes where other electronic devices were used, and 1,500 crashes where other distractions were present [12]. Using Kansas traffic accident facts for the five-year period (2010 to 2014) from the Kansas Department of Transportation (KDOT), it was seen that an average of 59,393 crashes; 2,076 distraction-affected crashes; and 506 crashes involving cell phone use occurred annually in the state of Kansas [12]. During that five year period, distraction-affected crashes accounted for 3.5% of all crashes, and crashes involving cell phone use accounted for 24.4% of all distraction-affected crashes. Figure 1.4 and Figure 1.5 show that the total number of overall crashes decreased by 1,101 (1.9%) over that period, whereas the total number of distraction-affected crashes and crashes involving cell phone use increased by 95 (4.5%) and 12 (2.3%), respectively. While overall crashes decreased, distraction-affected crashes and crashes involving cell phone use have increased.

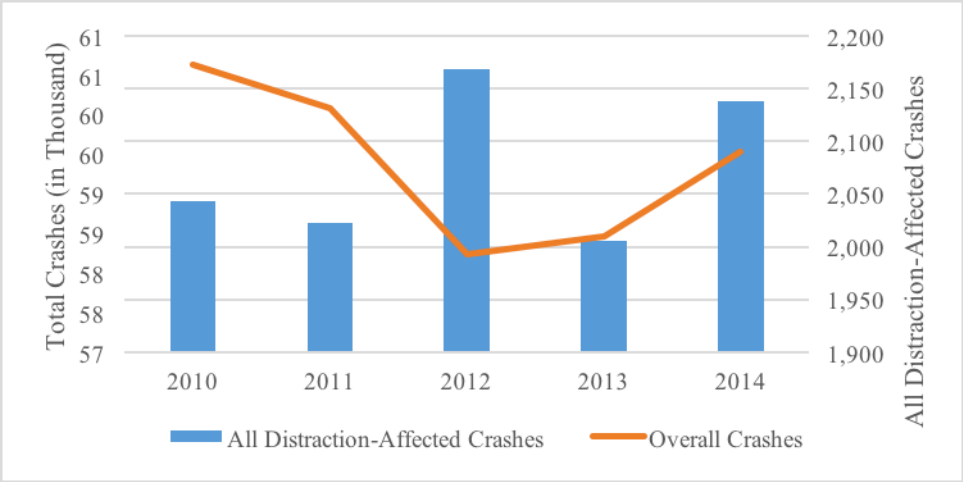


Figure 1.4 Overall Crashes and Distraction-Affected Crashes in Kansas from 2010 to 2014 [12]

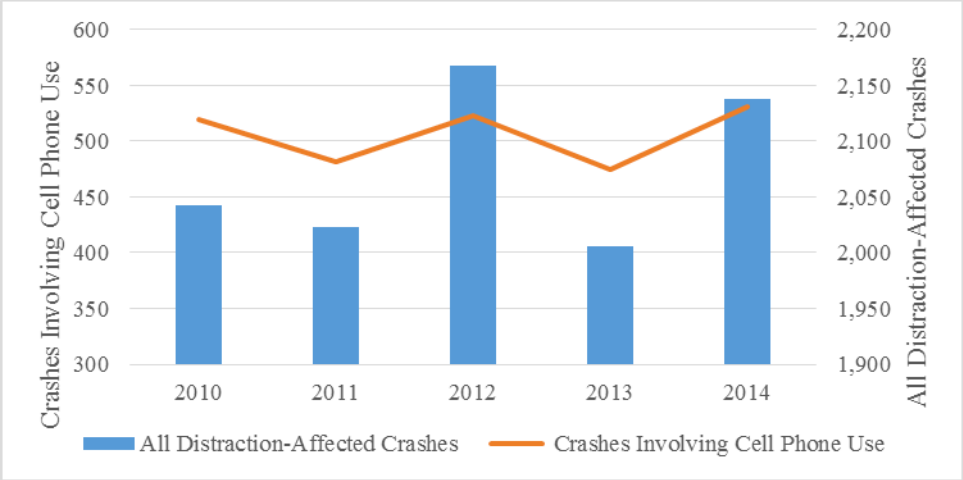


Figure 1.5 Distraction-Affected Crashes in Kansas from 2010 to 2014 [12]

Figure 1.6, which shows distracted drivers by age group in Kansas, reveals that the highest number of distracted drivers were young drivers. Therefore, it is reasonable to assume that young drivers have a higher crash risk on the roadways than drivers in other age groups.

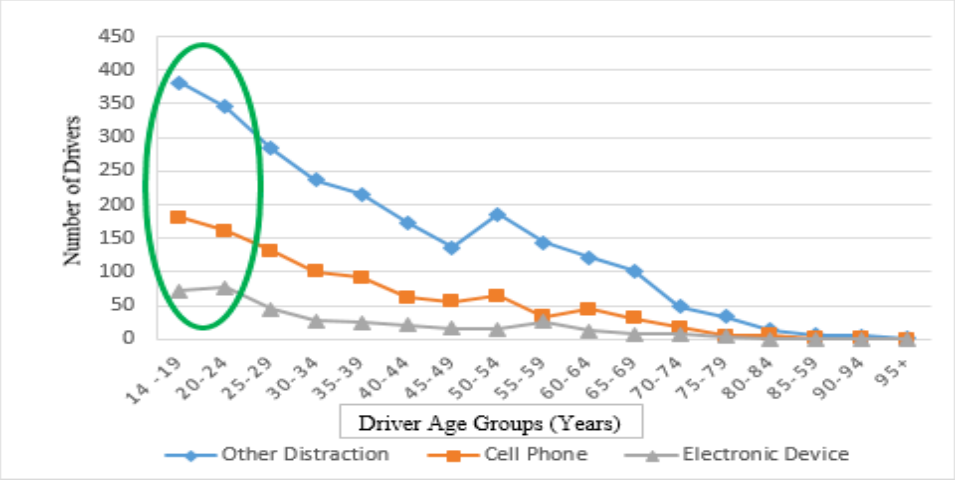


Figure 1.6 Distracted Drivers in Kansas by Age Group, 2016 [12]

These data suggest the importance of conducting research to identify the major factors that contribute to increases in the likelihood of distracted driving crashes that involve teenage and young-adult drivers in Kansas.

1.4 Research Objectives

The main objectives of this dissertation are to:

- Investigate how different distraction activities affect the most common crash types (i.e., rear-end, angular, and single-vehicle crashes) among teenage (15–20 year old) and young-adult (21–26 year old) drivers in Kansas.
- Provide a broader view of the severity of crashes in Kansas related to teenage and young-adult distracted drivers and their passengers.
- Evaluate teenage and young-adult drivers' attitudes and behaviors associated with distracted driving and cell phone use (e.g., talking or sending/reading text messages) while driving in Kansas.

1.5 Dissertation Organization

This dissertation is organized into five chapters. Chapter one includes a general introduction about distracted driving, the problem statement, the research objectives, and the organization of the dissertation. Chapter two presents a review of the literature on distracted driving, and chapter three outlines the crash data obtained, methodologies, and results from analyzing the crash data. Chapter four presents a detailed discussion of the survey data, including the development of the survey form, survey data collection, modeling, and analysis, and presents survey and model results related to young distracted drivers and their passengers. Chapter five presents the conclusions, study limitations, and recommendations for improving teenage and young-adult drivers' distraction safety.

Chapter 2 – Literature Review

Several studies show that teenage and young-adult drivers and their passengers are at a higher risk for crashes when involved with engage in technology and non-technology distractions. This chapter reviews previous studies concerning characteristics of teenage and young-adult drivers involved crashes, distracted driver-involved crashes, survey on distracted driving, cell phone related studies of distracted driving and countermeasures to reduce distracted driving.

2.1 Characteristics of Teenage and Young-Adult Driver Involved Crashes

Factors of teenage (16 years old) newly licensed drivers who involved injury and property damage only (PDO) crashes in Connecticut were investigated using the police crash reports and telephone interview data between March 2005 and February 2006 [13]. The participants' phone numbers were obtained using teenage drivers' information such as names and addresses that provided on police crash reports. The main focus of this study was on interviewing at-fault teenage drivers who were involved in crashes that occurred within 8 months of licensure. In this study, several contributing factors such as speeding, distraction by secondary tasks, change lane more frequency, and fatigued or asleep were investigated by gender and crash type. There were 893 serious injury and PDO crashes involving teenage drivers that occurred within study period, only 38% (260 drivers) of total teenage drivers were interviewed. The results indicated that 34% of teenage drivers involved in injury and PDO crashes were at fault, and a majority of the injury and PDO crashes of at-fault drivers were single-vehicle crashes or rear-end crashes. The major contributing factors to crashes of at-fault drivers were related to driver behavior included: failing to detect another vehicle or misunderstood traffic control devices, speeding, and losing control of the vehicle, or difficulty navigating slippery roads. In addition, the results showed that the main

reasons of failures to detect another vehicle and misunderstood traffic control devices were not looking thoroughly or looked in the wrong direction, distraction by secondary task, or inattention.

Dissanayake and Amarasingha identified contributory factors that increase the injury severity of teenage and young-adult driver crashes compared to middle-aged drivers in Kansas from 2006 to 2009 by using ordered logistic regression models [14]. The preliminary analysis of this study indicated that teenage and young-adult drivers were more probable to be involved in crashes due to speeding, failing to yield right-of-way or stop at an intersection, turning or lane changing, inattention, or distraction compared to middle-aged drivers. The ordered logistic regression model results indicated that driving at high speeds, driving older vehicles, driving with a teenage passenger, alcohol involvement, ejection or trapping at the time of the crash, and run-off-the road were main contributory factors that increase the injury severity of teenage and young-adult driver crashes compared to middle-aged drivers. In general, teenage and young-adult drivers in Kansas were more probable to be involved in injury severity crashes compared to middle-aged drivers.

Contributory factors that increase the hazard of fatal crashes involving teenage drivers (16-19 years old) were also examined using Missouri state crash data from 2002 to 2011 [15]. Cross-tabulation method was used to compare the frequencies of contributory factors among teenage and other age group drivers. In addition, a multinomial logistic regression model was used in this study to predict the likelihood of fatal crashes involving teenage drivers under different contributory factors. Cross-tabulation method results showed that driving too fast for conditions, speeding, passenger and cell phone distractions, driving on the wrong side of the road, alcohol, and improper lane usage were the most frequent contributory factors leading to

teenage drivers' fatal crashes. Likewise, based on a multinomial logistic regression model results, driving too fast for conditions, speeding, cell phone and passenger-related distractions, and driving on the wrong side were the main contributory factors that increase the hazard of fatal crashes involving teenage drivers.

Total distance, times, and trips driven within the two days survey period were examined among teenage drivers from 2004 to 2005, using Michigan Department of Transportation (MDOT) data from a state-wide self-reported survey. The sample included 1034 teenage drivers, only 56.4% of total teenage drivers reported driving a vehicle within the two days survey period. The results showed that teenage drove alone more distance, times, and trips during the day than at night. Teenage employees who lived in households with less than one licensed driver per vehicle drove more than those who unemployed and lived in households with one or more licensed driver per vehicle. Teenage drivers who lived in urban areas spent more times driving than those who lived in rural areas [16].

2.2 Distracted Driver Involved Crashes

Ghazizadeh, Mahtab, and Boyle studied the Missouri distraction-related crash from 2001 to 2006 [17]. During that period, distraction-affected crashes accounted for 1.17% of all crashes. A multinomial logistic regression model was developed to investigate how cell phone use, passengers, and other electronic devices use impact the likelihood that a driver will be involved in one of three most common collision types. These three collision types were rear-end, angular, and singular collisions represent 36.9%, 30.9%, and 13.5% of total crashes, respectively. Cell phone, passengers, and other electronic device distractions have accounted more than three-

fourths of distraction-affected crashes. In addition, various variables related to distraction types such as driver's age and gender, weather conditions, light conditions, and rural versus urban were included in the model, but the main focus was on three distraction types. The method that used for estimate the likelihood was by compare rear-end collisions with angular collisions, rear-end collisions with singular crashes, and angular collisions with singular crashes.

The model results of this study showed that drivers distracted by cell phones or passengers had a greater likelihood of being involved in angular crashes when compared to singular crashes and rear-end crashes [17]. However, drivers distracted by other electronic devices were more probable to be involved in singular crashes when compared to rear-end crashes and angular crashes. For other variables related to distraction types, the model results showed that drivers who drove on rural roadways or on dark had a greater likelihood of being involved in singular crashes when compared to rear-end crashes and angular crashes. In this study, future studies were recommended to be conducted across other states to clearly understand the type and severity of the crashes related to distracted drivers.

Nationally, Neyens, David, and Boyle used also a multinomial logit modeling to examine cognitive, cell phone use, inside the vehicle, and passenger related teenage drivers (16–19) distractions that would impact in one of three most common crash types: rear-end, angular, and single-vehicle crashes by using General Estimates System (GES) dataset [18]. The three crash types accounted for about 84% of all teenage drivers' crashes. Several variables related to distraction types such as speeding and alcohol use, road surface conditions, light conditions, urban versus rural, and intersection were also included in the model. Moreover, the interaction effects of these variables with distraction types were also examined in this study. According to multinomial logit modeling results, teenage drivers distracted by cell phones were more probable

to be involved in rear-end crashes when compared to single-vehicle crashes. The results of the analysis also revealed if teenage drivers distracted inside the vehicle, they were more probable to be involved in rear-end or single-vehicle crashes when compared to angular crashes. The research team found that teenage drivers who were distracted at intersections by passengers or cognitively were more likely to be involved in rear-end or angular crashes when compared to single-vehicle crashes. Additionally, they observed a similar trend in probability of a particular crash when teenage drivers drove in an urban roadway or during daylight. However, they found teenage drivers who drove on poor surface conditions or consumed alcohol were more probable to be involved in single-vehicle crashes than rear-end and angular crashes.

Another national study of teenage distracted drivers used U.S. DOT–General Estimates System crash data from 2003 [19]. The ordered logit modeling was used in this study to predict the probabilities of more severe injuries sustained by occupants (i.e., passengers and drivers) involved in crashes. This study included four driver distraction types: driver inattention, inside the vehicle, passengers, and cell phones which represented 21.0%, 1.6%, 0.7%, and 0.4% of all crashes, respectively. The results of the model showed that teenage drivers who distracted by cell phones or passengers were more probable to be injured compared when they were distracted inside the vehicle, inattentive, or not distracted. Teenage female drivers appeared to have a significantly increased likelihood of sustaining a severe injury than teenage male drivers when they were distracted in one of the four distraction types. In terms of passengers of teenage drivers, the model showed that passengers had a higher likelihood of being severely injured when their drivers distracted by cell phones, passengers or in-vehicle devices while driving than when their drivers were inattentive.

The effect of different driver distraction types and driver's age on the most common crash types (i.e., single-vehicle, angular, and rear-end) as well as injury severity sustained by drivers and their passengers involved in crashes were also examined by using the U.S. General Estimates System database from year 2003 to 2008 [20]. The distraction types in this study included: inattention, in-vehicle distraction, out of vehicle distraction, passenger related distraction, cell phones use, drowsiness, and no distraction. The preliminary analysis results showed that inattention accounted for 71% of all distraction-affected crashes.

According to multinomial logit modeling results, young drivers distracted by cell phones or out of vehicle or were inattention were more likely to be involved in rear-end crashes when compared to both single-vehicle and angular crashes [20]. However, the model results showed that young drivers who distracted by passengers, inside the vehicle, or were drowsy had a greater likelihood of being involved in single-vehicle crashes when compared to rear-end crashes and had a greater likelihood of being involved in rear-end crashes when compared to angular crashes. In addition, ordered logit modeling was built to predict the probability of severe injuries sustained by drivers and their passengers involved in crashes. This model results also supported that young drivers who sending or reading text messages while driving had a higher likelihood of being severely injured. While, they had a decreased likelihood of being severely injured when they were distracted by other distraction types.

Internationally, Lam used Traffic Accident Database System (TADS) from 1996 to 2000 in New South Wales, Australia to examine the role of the drivers' age in the relationship between distractions while driving, and the risk of crash injury by using a well-documented risk estimation method [21]. This study focused on four distraction categories: hand-held cell phone, other internal distraction, external distraction, and no distraction. There were 2,400 distraction-

affected fatal and injury crashes reported within study period which represented 3.8% of total fatal and injure crashes. More specifically, there were 30 hand-held cell phone uses-related fatal and injury crashes. The model results showed that 25–29 year-old drivers who distracted by a hand-held cell phone while driving were more likely to be killed or injured compared to other age groups. Moreover, the odds of their involvement in an injury crash was 2.4 times higher than those not being distracted. In addition, the model results indicated that there was a positive relationship between inside the vehicle distraction and risk of injury crash for almost all drivers. However, there was a negative relationship amongst external distraction and risk of crash injury for all drivers.

The relationship between distracted driving at highway-rail grade crossings (HRGCS) and driver, roadway, environment, and crossing characteristics were investigated using distracted driving data that was collected at five HRGCS in Lincoln, Nebraska and one HRGC in Fremont, Nebraska. Moreover, this study identified the relationship between driver distraction at the vicinity of highway-rail grade crossings and crash injury severity by using Nebraska crash database from 2008 to 2011 and Federal Railroad Administration Crossing Inventory data. A multinomial logit modeling was developed to investigate the correlation between distracted driving at HRGCS and driver, roadway, environment, and crossing characteristics. While ordered probit model was used to identify the association between driver distraction at the vicinity of HRGCS and crash injury severity. According to multinomial logit modeling results, nearby intersections and wet/icy road surface conditions were associated with increased external distractions. In addition, the results revealed that male drivers were less likely to eat/drink, cell phone use, smoke, or reach for an object while driving than female drivers. Drivers who drove with front-seat passengers were more often talk to passengers while driving. Based on ordered

probit model results, driver age, highway-rail grade crossings location, maximum train speed, five-year crash history, and nighttime tended to increase crash injury severity [22].

The 2010 Kentucky study [23] assessed the level of driver distraction in Kentucky. This assessment was accomplished through an analysis of 2008 Kentucky crash data and by conducting a survey of over 17,812 Kentucky drivers obtained at 21 survey locations. The survey form was built to determine the frequency of cell phone use while driving (e.g., cell phone use, hands-free cell use, and texting/dialing) and other distraction (e.g., eating, drinking, and grooming). The survey form is similar to the procedures and categories of the annual National Occupant Protection Use Survey observational study. According to crash data analysis, the research team found that total 962 crashes and 7 fatal crashes where cell phones were used while driving, total 4,819 crashes and 25 fatal crashes where other distractions were present and total 47,442 crashes and 152 fatal crashes where inattention were present. In other words, distraction-affected crashes has account for 43.1% of the total crashes and 24.5% of the fatal crashes in 2008. The results from the observational survey instrument indicated that the percentages of hand-held cell phone use, hands-free cell phones use, reading/sending text messages and other distraction were 7.3%, 0.2%, 0.9% and 1.6%, respectively. These findings were agree with the findings of observational study by NHTSA in 2008.

2.3 Survey on Distracted Driving

Li, Wanjun, Gkritza, and Albrecht used Iowa public opinion survey to determine the main factors that contributed to distracted driving in the state of Iowa in 2011[24]. The study sample included 1088 volunteer drivers who were residents of the Iowa state. A structural equation

modeling was used to estimate the association between volunteer drivers' socioeconomic and demographic status and attitudes and experiences on distracted driving. The preliminary analysis showed that there were highly correlated among participants' attitudes, experiences, and behaviors. Moreover, volunteer drivers' socioeconomic and demographic effect their attitudes and experiences on distracted driving. Also, the participants' responses related to answer or make phone calls while driving were impacted their attitudes and experiences on distracted driving. Most drivers perceived using a hands-free cell phone while driving is safer than using a handheld cell phone. However, drivers who often involved in distracted driving did not believe that distracted driving is serious safety concern compared to other drivers. The model results indicated that distracted drivers tend to be male, younger, rich, and have more formal education. Furthermore, male drivers were more probable to use their cell phones while driving for work-related reasons. In addition, the model results found that younger drivers (18 to 39 years old) were more exposed to engage in distracted driving.

The National Highway Traffic Safety Administration conducted a second national survey report to assess attitudes and behaviors related to distracted driving and cell phone use such as talking or reading/sending text messages while driving from February to June 2012 [25]. The survey collected over 6,016 drivers (16 and older) in the United States. Based on the survey findings, 33% of total responses were categorized as distraction-prone drivers and 67% of total responses were categorized as distraction-averse drivers. Young drivers and drivers of higher education level and income tend to be involved in distracted driving compared to other age group drivers. Drivers who drove every day and drivers who drove a few day a year were more probable to be involved in distracted driving than those who drove a few days a week.

In addition, the NHTSA survey results showed that almost half of drivers would at least sometimes accept a phone call while driving [25]. 58% of them continue to drive while talking on their phones, 17% ask the callers to call them later, 14% ask their passenger to answer their phones, and 11% pull over to the side of the road to continue the conversation. However, 40% of total responses reported that they never accept phone calls while driving. Almost one in four drivers reported that they are at least sometimes willing to make phone calls while driving, while almost two in four drivers reported that they are never willing to make phone calls while driving. For texting while driving, 10% of drivers reported at least some of the time sending messages while driving. Around half of them reported that they wait until they reach stop lights to send the messages, almost 35% said that they continue to drive while sending messages, 8% ask their passenger to send the messages, 7% use a voice command feature to send a message, and 6% pull over to safe locations to send a message. 14% drivers reported at least some of the time reading messages while driving. Most passengers of distracted drivers would feel very unsafe when their drivers doing various activities while driving. 5% of total drivers' crashes and near-crashes involved cell phone uses such as talking or sending/reading text messages.

A survey study conducted in New South Wales, Australia and Western, Australia investigated the frequency and effects of distraction while driving and evaluated the contribution of driver distraction to crashes by asking 1347 licensed drivers [26]. The results revealed that young drivers were more probable to drive with distractions including internal distractions, inattention, external distractions, and cell phones use while driving, and their weighted percentage were reported 80.8%, 75.7%, 72.5% and 11.0% of drivers, respectively. Male drivers were more probable to use their cell phones while driving than female drivers, while female drivers were more probable to talk to their passengers while driving. The survey data analysis

showed that 21% of total crashes were distraction-affected crashes and the most common crash types were rear-end crashes, crashes while reversing, crashes due to drivers lost control of their car, and running red light or stop sign crashes.

2.4 Cell Phone Related Studies of Distracted Driving

The previous study tested the frequency of texting while driving of 91 (60 women and 31 men) college students' drivers of mean age 22.8 from the northeastern United States [27]. The survey was collected via an Internet data collection site in 2010. The result showed that most of the participants reported that they use their cell phones for texting while driving with passengers (adult and children). In addition, a large number of participants reported driving above the speed limit and changing traffic lanes more frequently while texting. However, these participants agreed that sending/reading text messages while driving is unsafe and should have laws banning it. The interesting result showed that 38.5% of respondents reported that they eat and text at the same time while driving. In addition, 6.6 % of respondents had experience of ran a stop sign because they were sending/reading text messages while driving.

An international survey study assessed the factor that contribute in increasing cell phones use while driving in France [28]. This assessment was accomplished through interview 1,973 French drivers by phone in 2003. According to logistics regressions model results, male, young (18–24 years old) and middle age (35–44 years old), high and middle incomes, and married drivers were more probable to use their cell phones while driving. In particular, male drivers were more probable to use their cell phones while driving for work-related reasons. However, the

results exhibited that female drivers who drove long distances were more probable to use their cell phones while driving.

A simulator-based study conducted in Alabama investigated the behavior of teenage (16–18 years old) and young-adult (19–25 years old) who drove a STISIM simulator while distracted by cell phone. The results indicated that texting while driving lead to reduce driving speed, changed lanes more frequency, and increase crash occurrences. Furthermore, the results exhibited that the effects of cell phone use while driving was similar across both age groups (teenage and young-adult) [29].

2.5 Countermeasures to Reduce Distracted Driving

The National Highway Transportation Safety Administration suggested several countermeasures to reduce or prevent distracted driving included: launch several campaigns to increase public awareness about the impact of distracted driving on traffic safety, strong laws coupled with tough enforcement to decrease or prevent cell phone use while driving, improve young drivers educating, and establish self-responsibility for road safety among young drivers as well as other age group drivers [30]. In this section, some countermeasures from a number of previous studies that can use to reduce or avoid distracted driving and related crashes were reviewed and are discussed in terms of the following major themes:

- Cell phone use and texting while driving laws and high visibility enforcement,
- Graduated driver licensing (GDL), and
- Engineering, vehicular, and technology countermeasures.

2.5.1 Cell Phone and Texting While Driving Laws and High Visibility Enforcement

Two previous studies have examined the effectiveness of cell phone use bans in reducing hand-held cell phone use while driving in States with cell phone use bans that applied to all drivers (e.g., New York, Connecticut, and the District of Columbia). The first study found that cell phone use bans decreased hand-held cell phone use while driving by around 50% following enactment of cell phone bans [31], and a later study found these reductions in hand-held cell phone use while driving are maintained 3 to 7 years later [32]. Another investigation study conducted in 62 counties in New York State evaluated drivers' distraction-affected injury and fatal crashes before and after implemented a hand-held cell phone law restriction [33]. They found 46 counties had a significant reduction in drivers' distraction-affected injury crashes after implemented a hand-held cell phone law restriction, while 10 counties had a less significant reduction in drivers' distraction-affected fatal crashes. Furthermore, the effectiveness of texting bans in reducing crashes and insurance collision claims were examined in two previous studies [34 and 35]. However, these two studies found increases in different crash types and insurance collision claims after texting bans took effect. One possible reason for that might be texting drivers attempt to avoid fines by hiding their phones from view, which may result in spent more time looking away from the roadway [36].

Good laws coupled with highly-visible police enforcement can help to reduce talking and texting using a hand-held cell phone while driving. Consequently, the National Highway Traffic Safety Administration initiated a high-visibility enforcement (HVE) program to reduce talking and texting using a hand-held cell phone while driving in some States. Chaudhary et al found that the NHTSA high-visibility enforcement (HVE) program helped to reduce hand-held cell phone use while driving by about 57% in Hartford, Connecticut and 32% in Syracuse, New York

[37]. Another observational study observed similar reductions in cell phone use while driving after a HVE program took effect in California and Delaware [38].

Figure 2.1 and Figure 2.2 show the overall cell phone bans in the United States in 2012 and 2017 [39 and 40]. In 2012, only 10 states and the District of Columbia had hand-held cell phone use bans for drivers of all ages as primary enforcement. However, in 2017, this number increased to 14 states and the District of Columbia. Furthermore, hand-held cell phone use while driving by drivers of all ages is partial banned (i.e., driving in school zones and highway work zones) in four states, including Texas, Louisiana, Arkansas, and Wisconsin. In addition, hand-held cell phone use while driving by teenage drives (18-20 years old) is restricted in Arkansas as primary enforcement. The cell phone use such as talking or sending/reading text messages while driving by novice drivers is banned in 37 states and the District of Columbia. However, in Michigan, novice drivers whose involve in cell phone use-affected crashes or receive a ticket for using a cell phone may not use a cell phone while driving. Drivers of all ages are banned from sending/reading text messages in 46 states and the District of Columbia.

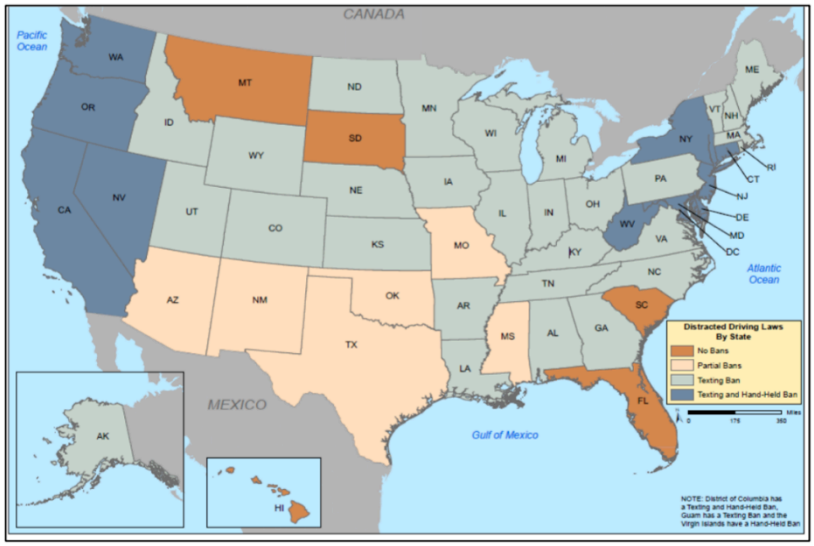


Figure 2.1 Cell Phone Use Bans by State, 2012
Source: [39]

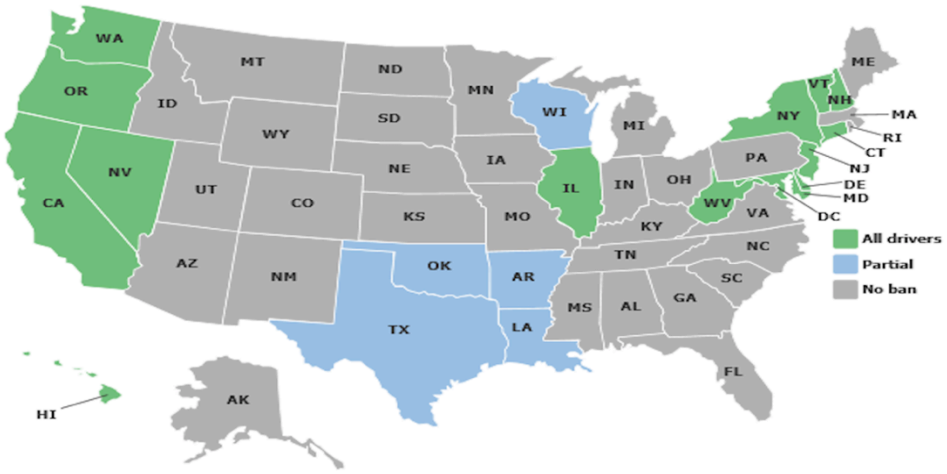


Figure 2.2 Hand-Held Cell Phone Use Bans by State, March 2017
Source: [40]

In the state of Kansas sending/reading text messages is restricted for drivers of all ages as primary enforcement, whereas handheld cell phone use while driving isn't banned for all drivers. However, Manhattan, Kansas where Kansas State University is located and Junction City, Kansas have enacted their own restriction on cell phone use (e.g., talking or sending/reading text messages) while driving. These two cities have hand-held cell phone use bans for drivers of all ages as primary enforcement [41].

2.5.2 Graduated Driver Licensing (GDL)

Effective of graduated driver licensing (GDL) in reducing teenage drivers' distraction-affected crashes have been investigated in previous studies. Several studies found a teenage passenger restriction contribute to a decrease teenage drivers' distraction-affected crashes [42, 43, 44, 45, and 46], whereas two previous studies conducted in North Carolina and Michigan did not reach a conclusion on effective of cell phone restrictions in reducing teenage drivers' distraction-affected crashes [47 and 48]. Conversely, according to a national study, Lim and Chi (2013) investigated the effective of cell phone bans in reducing teenage drivers (20 years old and younger) fatal

crashes by comparing states that had no cell phone bans, states that had cell phone bans that applied only to teenage drivers, and states that had cell phone bans that applied to all drivers [49]. They indicated that cell phone bans that applied to all drivers were contributed to decrease teenage drivers' fatal crashes, whereas cell phone bans that only applied to teenage drivers had no significant effect in reducing teenage fatal crashes.

2.5.3 Engineering, Vehicular, and Technology Countermeasures

There are several engineering, vehicular, and technology countermeasures strategies to reduce distracted driving and distraction-affected crashes. Centerline and shoulder rumble strips are used to alert distracted drivers as well as prevent distraction-affected crashes if they leave their travel lane. Furthermore, other roadway countermeasures such as wide and visible edge lines, more easily visible road signs, and better lighting at night, have demonstrated their effectiveness in reducing distraction-affected crashes [36].

Recently, several manufacturers have created several technology countermeasures can be implemented to reduce distracted driving. In-now vehicle technology such as crash avoidance technologies such as lane departure warning, crash-imminent braking, and forward crash warning hold promise can reduce distraction-affected crashes [50]. According to previous simulation study, 42 participants drove simulation vehicles while sending and reading text messages manually or using a voice command feature. This study found that both ways that participants used to send or read text messages while driving had no significant different in reaction times and participants spent more time looking away from the roadway [51]. According to the Governor Highway Safety Association [52], some driver safety apps can be installed onto the cell phone and block/filter phone cells or text messages (except emergency calls and pre-

specified numbers) while driving. Accordingly, previous study evaluated the effect of driver safety apps on the frequency cell phone use such as talking or sending/reading text messages of 44 participants [53]. This study found when the driver safety app was active, participants made and answered fewer calls while driving. Moreover, some devices can be installed in the vehicle which can detect when the vehicle is in motion and then would disable incoming calls, texting, emailing, and web surfing from a cell phone until the vehicle has stopped moving [52]. These driver safety apps and devices are potentially applicable to all drivers, especially for teenage drivers.

Chapter 3 – Data, Methodologies and Results for the Effects of Distractions on Crash Type and Injury Severity Sustained by Young Drivers and their Passengers Involved in Crashes

This chapter outlines crash data considered, methodologies, and results of the effects of distractions on crash type and injury severity sustained by young drivers and their passengers involved in crashes. A multinomial logistic regression model was developed to investigate how different distraction types influence the most common crash types among teenage drivers (15–20 year old) and young-adult drivers (21–26 year old). In addition, an ordered logistic regression model was used to identify the odds of more severe injuries for teenage and young-adult distracted drivers and their passengers. Additionally, this chapter presents analysis of crashes involving cell phone use in city with hand-held cell phone use ban and city without hand-held cell phone use ban, so that a direct comparison could be done.

3.1 Crash Database

Crash data for this study were obtained from the Kansas Crash and Analysis Reporting System (KCARS) database and the considered data covered five years from 2011 to 2015. The KCARS database consists of details of all police-reported crashes on Kansas public roads and streets, above a reporting threshold.

3.1.1 Organization Structure of the Crash Database

The KCARS database includes several files such as ACCIDENTS, DRIVERS, OCCUPANTS, PEDESTRIANS, TRUCKS, VEHICLES, ACCIDENT_CANSYS, SPECIAL_CONDITIONS,

TRAFFIC_CONTROLS, IMPAIRMENT_TESTS, SUBSTANCE_ABUSE, CC_DRIVER, CC_ENVIRONMENT, CC_ROADWAY, and CC_VEHICLE. In this study, only records from eight files were needed to examine teenage and young-adult distracted drivers involved in crashes. Those are: ACCIDENTS, DRIVERS, OCCUPANTS, VEHICLE, CC_DRIVER, CC_ENVIRONMENT, CC_ROADWAY, and CC_VEHICLE files. These eight related files can be briefly described as follows:

A. The "ACCIDENTS" file includes individual information for each crash such as crash location, light condition, weather condition, road surface type, road condition, road character, road class, urban/rural highways, road maintenance information, date of crash, time of crash, day of crash, accident class, collision type, and name of city, village, or township where the crash occurred, etc.
B. The "DRIVER" file includes information for each driver who was involved in each crash such as license compliance, restriction compliances, and alcohol impairment, etc.
C. The "OCCUPANT" file includes information for each occupant in the vehicle who was involved in each crash such as age, gender, injury severity, ejection, and use of safety equipment, etc.
D. The "VEHICLE" file includes specific information for each vehicle such as vehicle model, vehicle year, registration year, direction of travel, vehicle maneuver, vehicle damage, and number of occupants, etc.
E. The "CC_DRIVER" file contains driver-related contributing causes (i.e., driver condition at the time of crash, distracted driver, and driver actions at the time of crash).
F. The "CC_ENVIRONMENT, CC_ROADWAY, and CC_VEHICLE" files contain environmental, road, and vehicle-related contributing causes, respectively.

3.1.2 Creating of Distracted Driver File

Using the CC_DRIVER file, crashes that had driver distraction as a contributory cause (i.e., cell phone use, other electronic devices use, in/on vehicle distraction, external distraction and inattention) were isolated by querying and were sorted to a new file known as "DISTRACTED DRIVER", which contained distracted-driver involved crashes only. In the DISTRACTED DRIVER file, at least one type of driver distraction should be recorded per driver. However, some drivers had primary and secondary contributing causes to distracted driving. Based on Kansas Motor Vehicle Accident Report Coding Manual, inattention should be used as a secondary contributing cause to distracted driving along with other type of driver distraction such as cell phone use and external distraction [54]. In this study, the majority of secondary contributing causes to distracted driving affected crashes were inattention.

There were four scenarios of contributing causes to distracted driving used in this study to create DISTRACTED DRIVER file. The first scenario, when one driver involved in a crash that she/he was involved in one type of distractions as shown in Figure 3.1(a), this type of record was included in DISTRACTED DRIVER file as it is. The second scenario, if one driver involved in a crash that she/he was involved in two types of distractions as shown in Figure 3.1(b), the secondary contributing cause to distracted driving was removed from the file and only primary contributing cause was kept as the cause of distracted driving. In cases of two drivers involved in one crash, DISTRACTED DRIVER file only includes information about the distracted drivers involved in the crash as shown in Figure 3.1(c) and (d). In other words, drivers involved in distraction-related crashes, but were not distracted were eliminated them from the DISTRACTED DRIVER file.

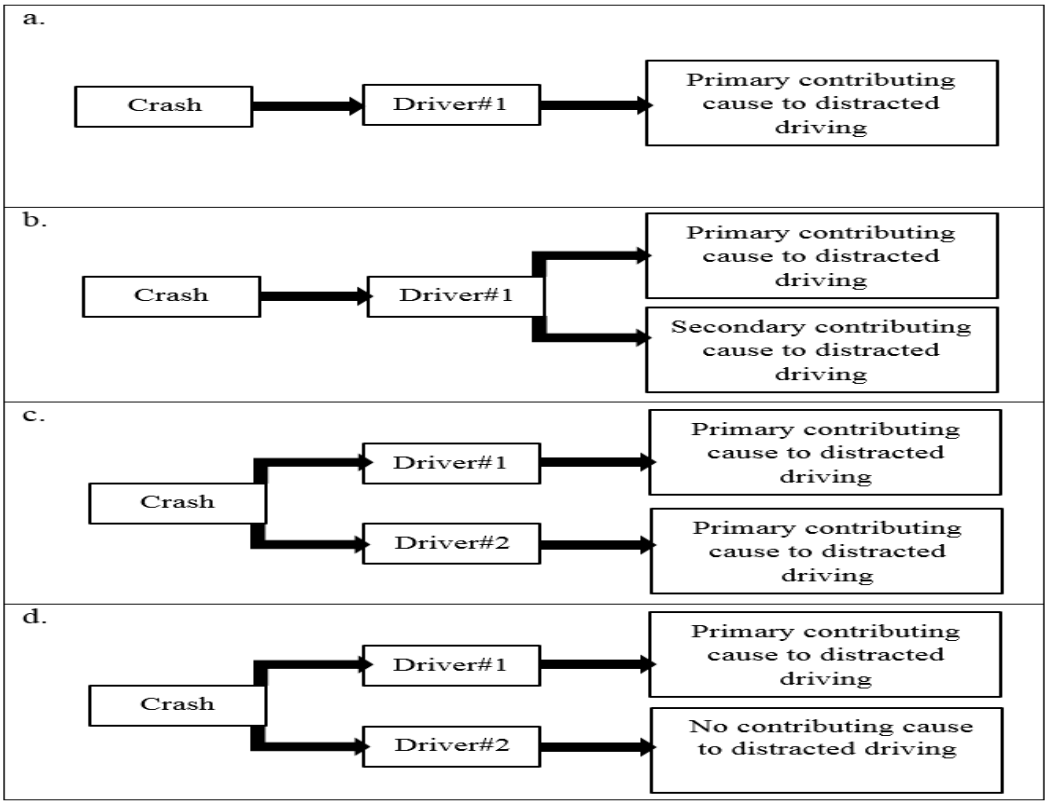


Figure 3.1 Contributing Causes to Distracted Driving Scenarios

3.2 Effects of Distractions on Crash Type

This section discusses the data description, methodologies, description of the selected variables, and results of the effects of distractions on crash type.

3.2.1 Data Description

3.2.1.1 Merging Data Files

As discussed earlier, eight files in the KCARS database provided sufficient information to examine teenage and young-adult distracted drivers who were involved in crashes. These files are organized in a relational format with unique crash record numbers "Accident Key" compiled together by calendar year. To achieve the objectives of this study, the data used should be driver-based instead of crash-based which mean each data record should correspond to a driver

involved in a crash. Therefore, Accident Key and Traffic Unit Number variables were used to combine the eight files together into one file. Accident Key is the most important variable contained in all files that links all data cases to their respective crash incidents. Traffic Unit Number is a variable contained in most files, which joins all people involved in crashes to their specific traffic unit number (i.e., motor vehicles in-transport).

The eight files were merged together into a single file by using a one-to-one merging technique in Microsoft Access software. In the first step, Accident Key and Traffic Unit Number were used to join the "DISTRACTED DRIVER" and "DRIVERS" files together to form a one file known as "Query1" file. Second step, the "VEHICLE" file was merged with the "Query1" file by using Accident Key and Traffic Unit Number to create a joint "Query2" file. Third step, the "OCCUPANT" file was merged with the "Query2" file by using Accident Key and Traffic Unit Number to create a joint "Query3" file. Fourth step, Accident Key and Traffic Unit Number were used to join the "CC_VEHICLE" and "Query3" files together in one file known as "Query4" file. Hence, the "ACCIDENTS" file was merged with the "Query4" file by using only Accident Key to create a joint "Query5" file. Finally, in individual steps Accident Key was used to merge the "CC_ENVIRONMENT", "CC_ROADWAY" and "Query5" files together in a new file known as "Final Query" file. Final Query file included only crash information for crashes that occurred when drivers were distracted. After sorting out the young distracted drivers, who were involved in crashes based on the driver's age, Final Query file ended up with 31,409 records of young drivers' distracted-affected crashes that occurred from 2011 to 2015. A flowchart showing the file merging process is schematically illustrated in Figure 3.2.

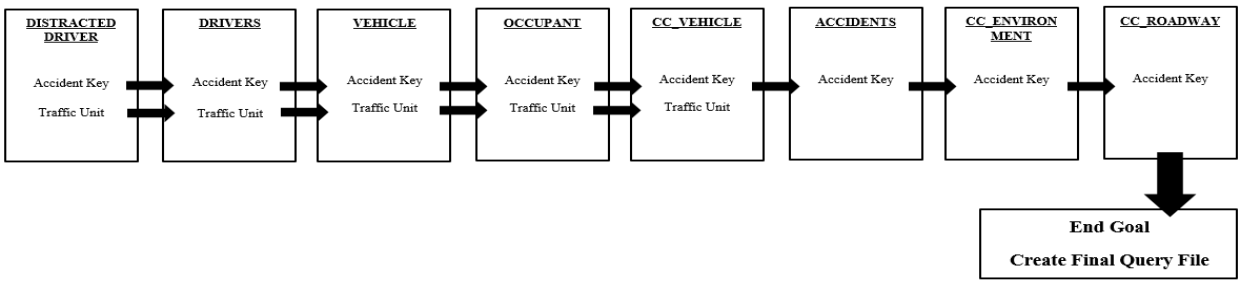


Figure 3.2 The Process of Creating a Joint Final Query File

3.2.1.2 Crash Type Classification

Table 3.1 shows the frequencies and percentages of different crash types in overall young drivers' crashes and young drivers' distraction-affected crashes. Based on crash type distribution, this study focused on the three most common types of crashes: rear-end collisions, angular collisions, and single-vehicle crashes. In fact, rear-end, angular, and single-vehicle crashes are the most common crash types for young and middle age drivers as well as older drivers [1]. In addition, these three crash types are also common crash types considered in some previous studies [17, 18, and 20]. During five-year period, rear-end, angular, and single-vehicle crashes accounted for 40%, 31%, and 8%, respectively of overall young driver crashes as shown in Table 3.1. In other words, these three crash types accounted for about 79% of overall young drivers' crashes.

The frequency of young drivers' distraction-affected crashes were counted as 31,409 crashes as shown in Table 3.1. When the data were reduced to include only the three most common crash types, the observations were decreased to 25,033 crashes. According to the data, the most common crash type is rear-end (46.5%), followed by single-vehicle (18%) and angle (15.1%). This is interesting since it exemplifies that the proportion of crashes based on crash types does not necessarily relate to the proportion of crashes observed based on distraction types.

Table 3.1 Frequency and Percentage of Young Drivers Involved crashes and Distraction-Affected Crashes (2011-2015)

Crash Type	Overall Young Drivers' Crashes		Young Drivers' Distraction-affected Crashes	
	Frequency	Percentage	Frequency	Percentage
Rear-end	103,812	39.9%	14,617	46.5%
Angle	79,530	30.6%	4,757	15.1%
Single-vehicle	21,713	8.3%	5,659	18.0%
Sideswipe: Same direction	17,060	6.6%	1,383	4.4%
Head on	6,660	2.6%	525	1.7%
Backed into	4,820	1.9%	426	1.4%
Sideswipe: opposite direction	3,727	1.4%	346	1.1%
Unknown/ other/blank	22,934	8.8%	3,696	11.8%
Total	260,256	100.0%	31,409	100.0%

Rear-end crashes occur between two vehicles that are both traveling in the same direction and are more likely occur due to improper braking or following too close. However, angular collisions occur when a vehicle comes into contact with a lead vehicle while traveling in the opposite direction. Single-vehicle crashes involve a collision between a vehicle and a fixed object on the road or on the side of the road, such as fences and buildings, trees, embankments, or any object implying immovable. Table 3.2 shows the frequency and proportions of the three most common crash types for both teenage and young-adult distracted drivers.

Table 3.2 Crash Types for Teenage and Young-Adult Distracted drivers (2011-2015)

Crash Types	Teenage Drivers		Young-adult Drivers	
	Number	%	Number	%
Rear-end	8,048	57.7%	6,569	59.3%
Single-vehicle	3,148	22.6%	2,511	22.7%
Angle	2,753	19.7%	2,004	18.1%
Total	13,949	100.0%	11,084	100.0%

3.2.2 Methodologies

3.2.2.1 Introduction

As mentioned previously, the main objective of this study was to investigate whether teenage and young-adult distracted drivers, or their interaction with other factors have significant effects on collision types. Moreover, this study tested the effects of other factors (e.g., driver, environmental, and crash characteristics) on collision types. Rear-end collisions, angular collisions, and single-vehicle crashes were the most common crash types in the young drivers' distraction related crash data. Consequently, these three crash types were used as the dependent variable for model estimation. Because the dependent variable (crash types) in this study has multi-level unordered categories, multinomial logistic regression was selected as the model estimation. The multinomial logistic regression model is used for modeling unordered categories where the dependent variables are discrete in nature [55].

A multinomial logistic regression model is widely used in traffic safety studies. Several studies used multinomial logistic regression model to investigate how different distraction factors impact rear-end, angular, and single-vehicle crash types [17, 18, and 20]. Other previous studies used multinomial logit model to identify the correlation between distracted driving at highway-rail grade crossings and driver, roadway, environment, and crossing characteristics [22]. In addition, Xeudong, Yan, et al (2009) used multinomial logistic regression model to identify risk factors associated with truck-car, car-truck, and car-car angle collisions [56].

3.2.2.2 Multinomial Logistic Regression

A multinomial logistic regression model is a simple extension of a binary logistic model, but a multinomial logistic regression model can treat more than two unordered categories of outcomes

[55]. In other words, multinomial regression is a preferable technique used in traffic safety studies to assess more than two unordered categories of the dependent variable [17]. A multinomial logistic regression model uses the method of the maximum likelihood estimation to assess the probability that the dependent variable will be in one category as compared to another category. In this study a multinomial logit modeling was used to identify the odds that a driver with a certain type of distraction or under different factor or condition would be involved in one of the three most common crash types: rear-end, angular, and single-vehicle crashes. These three categories can be represented in three binary logit equations. Thus, the binary logit equations are performed to compare: rear-end crashes versus single-vehicle crashes (eqn. 3.1); angular crashes versus single-vehicle crashes (eqn. 3.2); and rear-end crashes versus angular crashes (eqn. 3.3).

$$\log\left(\frac{P_{i1}}{P_{i3}}\right) = \beta_1 x_i \rightarrow \frac{P_{i1}}{P_{i3}} = \exp(\beta_1 x_i) \tag{3.1}$$

$$\log\left(\frac{P_{i2}}{P_{i3}}\right) = \beta_2 x_i \rightarrow \frac{P_{i2}}{P_{i3}} = \exp(\beta_2 x_i) \tag{3.2}$$

$$\log\left(\frac{P_{i1}}{P_{i2}}\right) = \beta_3 x_i \rightarrow \frac{P_{i1}}{P_{i2}} = \exp(\beta_3 x_i) \tag{3.3}$$

where,

P_{i1} = probability of a rear-end crash for observation i,

P_{i2} = probability of an angular crash for observation i,

P_{i3} = probability of a single-vehicle crash for observation i,

x_i = explanatory variables for observation i, and

$\beta's$ = parameter estimates.

Using properties of logarithms,

$$\log\left(\frac{P_{i1}}{P_{i2}}\right) = \log\left(\frac{P_{i1}}{P_{i3}}\right) - \log\left(\frac{P_{i2}}{P_{i3}}\right) = (\beta_1 - \beta_2)x_i \tag{3.4}$$

This implies that $\beta_3 = \beta_1 - \beta_2$. Due to the sum of probabilities being one $(P_{i1} + P_{i2} + P_{i3} = 1)$, the probabilities are calculated using the following equations respectively;

$$P_{i1} = \frac{\exp(\beta_1 x_i)}{1 + \exp(\beta_1 x_i) + \exp(\beta_2 x_i)} \tag{3.5}$$

$$P_{i2} = \frac{\exp(\beta_2 x_i)}{1 + \exp(\beta_1 x_i) + \exp(\beta_2 x_i)} \tag{3.6}$$

$$P_{i3} = \frac{1}{1 + \exp(\beta_1 x_i) + \exp(\beta_2 x_i)} \tag{3.7}$$

3.2.2.3 Two-Way Interaction Model

Adding 2-way interaction to a multinomial logistic regression model can help to understand the relationships among the distraction types and other independent variables. The main effects and 2-way interaction is given by;

$$E(y) = \beta_0 + \overbrace{\beta_1 x_1 + \beta_2 x_2}^{\text{Main effect terms}} + \overbrace{\beta_3 x_1 x_2}^{\text{Interaction term}} \tag{3.8}$$

where,

x_1 = driver distraction types,

x_2 =other explanatory variables,

$x_1 x_2$ = 2-way interactions between driver distraction types and other explanatory variables, and

β_3 = interaction parameter estimates.

The odds ratio estimates in the multinomial logistic regression model output show only the odds ratio and confident interval (CIs) estimates for those variables which are not involved in any interaction terms (for two explanatory variables). In this study, since the multinomial logistic regression model contains the interaction terms of teenage and young- adult drivers' distraction with other explanatory variables, the odds ratio and confident interval (CIs) estimates for interaction variables and interaction terms were not computed in the model outcome directly. Consequently, before running the model, new independent variables were created which contained interactions between distraction types and other original independent variables. Hence, these new independent variables were included in the multinomial logistic regression model statement. This advanced step is widely used in statistical studies, because it is useful to compute the odds ratio and confident interval (CIs) for interaction variables and interaction terms in the model in addition to other statistical estimations [57].

3.2.2.4 Odds Ratio

Logistic regression model can be employed in calculating odds ratio and 95% Confidence Intervals (CIs) to measure the association between two dichotomous variables. The odds ratio is a common tool that is extensively used in traffic safety studies because it is useful in comparing whether the probability of a certain event is the same for two groups [55]. The odds of an event

can be defined as the ratio of the probability that an event occurs to the probability that it does not occur [55]. The odds ratio can be calculated by;

$$Odds = \frac{P}{1-P} = \frac{P(y=1/x_1, x_2, \ldots\ldots\ldots\ldots, x_p)}{P(y=0/x_1, x_2, \ldots\ldots\ldots\ldots, x_p)} \tag{3.9}$$

where,

$P(y=1/x_1, x_2, \ldots\ldots\ldots\ldots, x_p)$= probability of event occurring, and

$P(y=0/x_1, x_2, \ldots\ldots\ldots\ldots, x_p)$= probability of event not occurring.

Note that OR > 1.0 correspond to probabilities greater than 50%, while OR < 1.0 correspond to probabilities less than 50%, when the value of one of the independent variables ($odds_2$) is increased by 1.0 unit.

$$OR = \frac{odds_1}{odds_2} \tag{3.10}$$

Odds ratios are directly related to the parameters in the logistic regression model.

$$OR = \exp(\beta_j) \tag{3.11}$$

where,

β_j = the parameter estimates of the j^{th} independent variable of a logistic regression model.

The 95% confident interval (CIs) is given by;

$$\left(\exp\left(\beta_j - 1.96 s_{\beta_j}\right), \exp\left(\beta_j + 1.96 s_{\beta_j}\right)\right) \qquad (3.12)$$

where,

s_β = the standard error of the coefficient β.

3.2.2.5 Likelihood Ratio (LR)

The Likelihood Ratio (LR) Chi-Square is used to test the significance of the selected model. The LR test statistic can be calculated by;

$$\text{LR} = -2\log\text{L}\left(\text{null model}\right) - 2\log\text{L}\left(\text{fitted model}\right) \qquad (3.13)$$

where,

$\text{L}\left(\text{null model}\right)$ = model with only the intercept term, and

$\text{L}\left(\text{fitted model}\right)$ = model with all specified variables (i.e., Intercept and Covariates).

Log-likelihood value can be used to compare two models that have same sample size. Hence, the model with the largest value of log-likelihood is the preferred model.

3.2.2.6 Akaike Information Criterion (AIC)

AIC can be used to compare two models with the same sample size. The model with the smallest AIC value is suggested as a preferred model fit [55]. AIC is calculated as;

$$AIC = -2\log L + 2\left(\left(k-1\right) + s\right) \qquad (3.14)$$

where,

L = likelihood of the model,

k = the number of levels of the explanatory variable, and

s = the number of predictors in the model.

3.2.2.7 Schwarz Criterion (SC)

SC is calculated as;

$$SC = -2\log L + \left((k-1)+s\right)*\log\left(\sum f_i\right) \qquad (3.15)$$

where,

L = likelihood of the model,

k = the number of levels of the explanatory variable,

s = the number of predictors in the model, and

f_i = the frequency values of the i^{th} observation.

Like AIC, the model with the smallest SC value is suggested as a good model fit.

3.2.2.8 Significant Variables Selection

The final models were built based on selected variables that are significantly related to the most common crash types at a confidence level of 95% by using a stepwise selection process. The stepwise selection process procedures can be done in two steps; the first step, fit all possible one-variable models;

$$E(y) = \beta_0 + \beta_1 x_i \qquad (3.16)$$

where,

x_i = explanatory variables for observation $i = (1,....,k)$.

Hence, choose the best variable, which has the smallest and significant "p-value". The second step, fit all possible two-variable models;

$$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_i \qquad (3.17)$$

where,

x_1 = explanatory variable selected in the first step, and

x_i = options for the second explanatory variable for observation $i = (2,....,k)$.

Hence, choose the best variable, which has the smallest and significant "p-value" among the remaining $k-1$ explanatory variables; if none of variables is significant, the selected model in the previous step is considered as the final model. Note, before proceeding to the next step, stepwise selection process checks the significance of one-variable models; if is non-significant, then it will be replaced by the next best variable. These steps were repeated until the final model is finalized.

3.2.2.9 Multicollinearity

Multicollinearity occurs when two or more independent variables are highly correlated with each other. The collinearity can result in several problems when present in the logistic regression analysis, including [55 and 58]:

- Standard errors and confidence intervals for the highly correlated explanatory variables may get large,
- The logistic regression results may be confusing and misleading,

- Parameter estimates may have opposite signs from what is expected or implausible magnitudes, and
- The logistic regression results may show that none of the highly correlated explanatory variables has a statistically significant influence on predicting the dependent variable when both of them are included in the model.

In this study, a correlation matrix was developed to detect the correlation among all pairs of explanatory variables. One of the major solutions to solve the multicollinearity related issues is to remove one of the correlated variables from the model. This is because the explanatory variables are collinear, so the model fit would be affected if both correlated variables were removed from the model. There is no definite cut off value for the Correlation Coefficient, however the most common value is 0.6 or more which indicates that one explanatory variable is highly correlated with one another [59]. Therefore, one of the correlated variables that causes to increase AIC and SC values was removed from the model.

3.2.3 Description of the Selected Variables

This section presents the characteristics of distraction-affected crashes that occurred in Kansas between 2011 and 2015. These characteristics were divided into seven categories as depicted in Tables 3.3 through 3.9; which are distraction types for teenage and young-adult drivers, crash related characteristics, driver related characteristics, roadway related characteristics, vehicle related characteristics, environmental related characteristics, and contributory causes, respectively. The seven tables include the crash frequencies and percentages for teenage and young-adult drivers considered in the current study. All these characteristics have been identified

in previous studies as having an influence on driver distractions, crash types, and young drivers [14, 17, 18, 19, and 20].

3.2.3.1 Teenage and Young-Adult Drivers' Distraction Types

The crash frequencies and percentages of five distraction types are shown in Table 3.3, which include:

- Inattention in general sense and drowsiness,
- Other in or on vehicle distraction (grooming, reading newspaper, talking to other passengers, adjusting radio, talking or interacting with children, eating, or drinking, etc.),
- Cell phone use (e.g., calling, texting, use for driving directions, etc.),
- External distraction (i.e., an item or action not in or on vehicle), and
- Other electronic devices use (audio, video, GPS, computer, etc.)

A majority of teenage and young-adult drivers' distraction-affected crashes occurred when the drivers were inattentive. More than 1 in 10 teenage and young-adult drivers' distraction-affected crashes occurred when they distracted in or on vehicle. Approximately 4% of teenage and young-adult drivers' distraction-affected crashes occurred when they used cell phones while driving.

Table 3.3 Crash Frequencies and Percentages of Distraction Types by Teenage and Young-Adult Drivers for Period of (2011-2015)

Types of distraction	Teenage Drivers		Young-adult Drivers	
	Number	%	Number	%
Inattention	11,275	80.8%	8,929	80.6%
Other in or on vehicle distraction	1,413	10.1%	1,140	10.3%
Cell phone use	541	3.9%	480	4.3%
External distraction	403	2.9%	345	3.1%
Other electronic devices use	317	2.3%	190	1.7%
Total	13,949	100.0%	11,084	100.0%

3.2.3.2 Crash-Related Characteristics

According to Table 3.4, injury severity is coded into four categories, which include not injured, non-incapacitating injury/possible injury, fatal injury/incapacitating injury, and unknown/others. In addition, their frequencies of occurrences were analyzed and the data show that they were 85.6%, 12.6%, 1.0%, and 0.9%, respectively of total teenage drivers' distraction-affected crashes, while 84.4%, 12.9%, 1.3%, and 1.4%, respectively of total young-adult drivers' distraction-affected crashes. In terms of vehicle damage, it was recorded for both teenage and young-adult drivers that disabling damage made up of about 37%, functional damage 30%, minor damage 22%, destroyed 7% and no damage 1% of total distraction-affected crashes. Vehicle maneuver was coded with five category levels. The largest recorded category for both teenage and young-adult drivers was straight-following the road, which constituted more than three-fourths of total distraction-affected crashes, and the second largest recorded category for both teenage and young-adult drivers was turning or changing lanes maneuver, which constituted more than 1 in 10 distraction-affected crashes. The other three categories include stopped vehicles, parking or backing, avoiding maneuver, and unknown/others had less crash frequencies of occurrence.

Table 3.4 Crash Frequencies and Percentages by Teenage and Young-Adult Distracted Drivers: Crash-Related Characteristics for Period of (2011-2015)

Crash-Related Characteristics	Teenage Drivers		Young-adult Drivers	
	Number	%	Number	%
Injury Severity				
Not injured	11,935	85.6%	9,356	84.4%
Non-incapacitating injury /possible injury	1,754	12.6%	1,432	12.9%
Fatal injury/incapacitating injury	133	1.0%	140	1.3%
Unknown/others	127	0.9%	156	1.4%
Ejection				
Not ejected	13,713	98.3%	10,860	98.0%
Trapped	74	0.5%	68	0.6%
Ejected	61	0.4%	64	0.6%
Unknown/others	101	0.7%	92	0.8%
Vehicle Damage				
Disabling	5,286	37.9%	4,110	37.1%
Functional	4,311	30.9%	3,317	29.9%
Minor damage	3,039	21.8%	2,554	23.0%
Destroyed	1,045	7.5%	829	7.5%
No damage	188	1.3%	171	1.5%
Unknown/others	80	0.6%	103	0.9%
Vehicle Maneuver				
Straight-following	10,733	76.9%	8,413	75.9%
Turn or changing lanes	1,865	13.4%	1,462	13.2%
Stopped, parking or backing	878	6.3%	777	7.0%
Avoiding maneuver	287	2.1%	278	2.5%
Unknown/others	186	1.3%	154	1.4%
Total	13,949	100%	11,084	100%

3.2.3.3 Driver-Related Characteristics

Table 3.5 summarizes the description of driver related characteristics. In terms of gender of teenage drivers, males were involved in more than half of total distraction-affected crashes, while females made up 46.4%. However, in terms of gender of young-adult drivers, there were slightly different in crash frequencies of occurrences, and the data revealed that males were involved in 6 out of 10 distraction-affected crashes, while females made up of 43.9%. Teenage

drivers with a valid license made up of 93.4% of all the teenage drivers involved in distraction-affected crashes, while young-adult drivers with a valid license made up of only 89.2% of all the young-adult drivers who were involved in the distraction-affected crashes. Alcohol and drugs were involved in only 2.0% of all teenage driver distraction-affected crashes, while they were involved in 5.3% of all young-adult driver distraction-affected crashes.

Table 3.5 Crash Frequencies and Percentages by Teenage and Young-Adult Distracted Drivers: Driver-Related Characteristics for Period of (2011-2015)

Driver-Related Characteristics	Teenage Drivers		Young-adult Drivers	
	Number	%	Number	%
Gender				
Male	7,464	53.5%	6,211	56.0%
Female	6,473	46.4%	4,863	43.9%
Unknown/others	12	0.1%	10	0.1%
License Compliance				
Valid licensed	13,034	93.4%	9,884	89.2%
Not valid licensed	780	5.6%	1,074	9.7%
Unknown/others	135	1.0%	126	1.1%
Restriction Compliance				
No restrictions on driver license	9,760	70.0%	7,498	67.6%
Restricted license	3,488	25.0%	2,975	26.8%
Unknown/others	701	5.0%	611	5.5%
Safety Equipment used				
Safety belt used	12,991	93.1%	10,088	91.0%
Safety belt not used	475	3.4%	484	4.4%
Unknown/others	483	3.5%	512	4.6%
Alcohol/Drug Related				
Alcohol/drug not related	13,666	98.0%	10,502	94.7%
Alcohol/drug related	283	2.0%	582	5.3%
Total	13,949	100.0%	11,084	100.0%

3.2.3.4 Roadway-Related Characteristics

Roadway related characteristics of teenage and young-adult driver distraction-affected crashes are displayed in Table 3.6. The highest observations of teenage and young-adult drivers'

distraction-related traffic crashes occurred at intersections, while about one-third of such crashes occurred on roadway and 15.0% occurred off-roadway. Furthermore, Table 3.6 shows that the most significant road surface type for both teenage and young-adult drivers is the black top, where nearly three-fourths of all distraction-affected crashes occurred, the second one is the concrete surface type with nearly one-fourth of all distraction-affected crashes, and 5.2% and 3.6%, respectively of the observed distraction-affected crashes occurred in the gravel/brick or other surface types. In terms of road surface conditions when teenage and young-adult drivers' distraction-affected crashes took place, where a large majority of the crashes happened when the road surface conditions were dry, and about 13.0% occurred when the road surface conditions were either wet or with debris.

In terms of the road surface character, the data reveal that 92.5% of total teenage drivers' distraction-affected crashes occurred on straight roads and only 6.9% took place on curved roads, while straight roads involved in 91.4% of total young-adult drivers' distraction-affected crashes and only 8.0% took place on curved roads. As shown in Table 3.6, posted speed limit was divided into three category levels. The majority of teenage and young-adult drivers' distraction-affected crashes occurred on roads with posted speed limits of 35-60 mph, while one- fourth occurred on roads with posted speed limits less than 35 mph, and more than 10.0% took place on roads with posted speed limits above 60 mph. Additionally, the data show that the highest number of teenage and young-adult drivers' distraction-affected crashes occurred on multi-lane roadways. Likewise, data indicate that the highest number of teenage and young-adult drivers' distraction-affected crashes occurred when there were no road construction or maintenance activities.

Table 3.6 Crash Frequencies and Percentages by Teenage and Young-Adult Distracted Drivers: Roadway-Related Characteristics for Period of (2011-2015)

Road-Related Characteristics	Teenage Drivers		Young-adult Drivers	
	Number	%	Number	%
Crash Location				
Intersection	7,133	51.1%	5,866	52.9%
On roadway	4,630	33.2%	3,575	32.3%
Off-roadway	2,155	15.4%	1,610	14.5%
Unknown/others	31	0.2%	33	0.3%
Road Surface Type				
Black top	9,795	70.2%	7,464	67.3%
Concrete	3,410	24.4%	3,209	29.0%
Gravel/brick or other	719	5.2%	401	3.6%
Unknown	25	0.2%	10	0.1%
Road Surface Condition				
Dry	12,089	86.7%	9,606	86.7%
Wet/debris	1,798	12.9%	1,440	13.0%
Unknown/others	62	0.4%	38	0.3%
Road Surface Character				
Straight	12,909	92.5%	10,135	91.4%
Curved	963	6.9%	888	8.0%
Unknown/others	77	0.6%	61	0.6%
Posted Speed Limit				
Less than 35 mph	4,112	29.5%	3,087	27.9%
35-60 mph	8,258	59.2%	6,339	57.2%
More than 60 mph	1,403	10.1%	1,513	13.7%
Unknown/others	176	1.3%	145	1.3%
Number of Lanes				
Multi lanes	13,490	96.7%	10,701	96.5%
Single lane	363	2.6%	326	2.9%
Unknown/others	96	0.7%	57	0.5%
Construction/Maintenance Zone				
No work zone	13,498	96.8%	10,682	96.4%
Work zone	402	2.9%	381	3.4%
Unknown/others	49	0.4%	21	0.2%
Total	13,949	100.0%	11,084	100.0%

3.2.3.5 Vehicle and Passenger Characteristics

Vehicle and passenger characteristics of teenage and young-adult driver distraction-affected crashes are presented in Table 3.7. In terms of vehicle type, it was recorded that automobile made up about 66.0%, pickup-truck/ camper-rv 15.0%, sport utility vehicle 15.0%, and van 3.0% of total teenage and young-adult drivers' distraction-affected crashes. As shown in Table 3.7, the majority of teenage drivers' distraction-related crashes occurred when they drove old vehicles, while one-third took place when they drove vehicles aged 11-15 years, about 1.5 in 10 occurred while they drove vehicles age 6-10 years, and only 3.4% occurred when they drove new vehicles. However, in terms of young-adult drivers, there were different crash distributions, and the data reveal that the highest number of young-adult drivers' distraction-related crashes occurred when they drove old vehicles or vehicles age 11-15 years, while about one-fourth occurred when they drove vehicles age 6-10 years, and 7.3% occurred when they drove new vehicles.

Distraction-related crashes that happened when passengers were present at the time of the crash were more than one-fourth of the total teenage drivers' distraction-affected crashes and only 21.7% of the total young-adult drivers' distraction-affected crashes. In terms of gender of front-seat passengers, male passengers were involved in 12.7% of total teenage drivers' distraction-affected crashes and only 8.0% of total young-adult drivers' distraction-affected crashes. However, female passengers were involved in 11.5% of total teenage drivers' distraction-affected crashes and only 7.7% of total young-adult drivers' distraction-affected crashes. The data show the interesting facts of crash frequency, when teenage (15–20 year old) front-seat passengers were present at the time of the crash, they made up 16.5% of total teenage drivers' distraction-affected crashes, but they only made up 3.4% total young-adult drivers' distraction-affected crashes.

Table 3.7 Crash Frequencies and Percentages by Teenage and Young-Adult Distracted Drivers: Vehicle-Related Characteristics for Period of (2011-2015)

Vehicle-Related Characteristics	Teenage Drivers		Young-adult Drivers	
	Number	%	Number	%
Vehicle Type				
Automobile	9,293	66.6%	7,284	65.7%
Pickup-truck/camper-rv	2,162	15.5%	1,740	15.7%
Sport utility vehicle	2,148	15.4%	1,741	15.7%
Van	341	2.4%	307	2.8%
Unknown/others	5	0.0%	12	0.1%
Vehicle Age				
Year 16 or older	6,808	48.8%	4,218	38.1%
11-15 years	4,607	33.0%	3,673	33.1%
6-10 years	2,008	14.4%	2,346	21.2%
Year 5 or newer	481	3.4%	809	7.3%
Unknown/others	45	0.3%	38	0.3%
Occupants				
Only driver	10,227	73.3%	8,669	78.2%
Driver and passengers	3,714	26.6%	2,403	21.7%
Unknown/others	8	0.1%	12	0.1%
Gender of Front-Seat Passengers				
Male	1,770	12.7%	887	8.0%
Female	1,599	11.5%	852	7.7%
Non-occupant/unknown	10,580	75.8%	9,345	84.3%
Teenage Front-Seat Passengers				
Yes	2,303	16.5%	382	3.4%
No	11,646	83.5%	10,702	96.6%
Total	13,949	100.0%	11,084	100.0%

3.2.3.6 Environmental-Related Characteristics

Environmental-related characteristics were also investigated using Kansas crash data. In terms of light condition, the data indicate that the highest number of total teenage and young-adult drivers' distraction-related traffic crashes took place during daylight, and about one-fourth happened during nighttime on unlit (dark) roadways. Furthermore, Table 3.8 reveals that a large majority of teenage and young-adult drivers' distraction-related traffic crashes occurred when the

weather was normal, and only about 9.0% of total teenage and young-adult drivers' distraction-related traffic crashes took place during adverse weather conditions.

Table 3.8 Crash Frequencies and Percentages by Teenage and Young-Adult Distracted Drivers: Environmental-Related Characteristics for Period of (2011-2015)

Environmental-Related Characteristics	Teenage Drivers		Young-adult Drivers	
	Number	%	Number	%
Light Conditions				
Daylight	10,728	76.9%	8,227	74.2%
Dark	3,202	23.0%	2,841	25.6%
Unknown/others	19	0.1%	16	0.1%
Weather Conditions				
Normal conditions	12,582	90.2%	9,985	90.1%
Adverse conditions	1,327	9.5%	1,070	9.7%
Unknown/others	40	0.3%	29	0.3%
Functional Class				
Urban roads	10,514	75.4%	8,753	79.0%
Rural roads	2,944	21.1%	1,839	16.6%
Unknown/others	491	3.5%	492	4.4%
Time of Crash				
5.00-9.00-Morning	1,963	14.1%	1,643	14.8%
9.00-13.00-Noon	2,315	16.6%	2,014	18.2%
13.00-17.00-Afternoon	4,740	34.0%	3,348	30.2%
17.00-21.00-Evening	3,268	23.4%	2,495	22.5%
21.00-5.00-Night	1,636	11.7%	1,574	14.2%
Unknown/others	27	0.2%	10	0.1%
Day of Week				
Week days	10,877	78.0%	8,579	77.4%
Weekend	3,071	22.0%	2,503	22.6%
Unknown/others	1	0.0%	2	0.0%
Total	13,949	100.0%	11,084	100.0%

In terms of functional class, the data show that the highest observations of teenage and young-adult drivers' distraction-related traffic crashes occurred on urban roads, while the rest of teenage and young-adult drivers' distraction-related traffic crashes occurred on rural roads with 21.1% and only 16.6%, respectively. Moreover, data show the time of the day when the teenage

and young-adult drivers' distraction-affected crashes took place. The majority of distraction-affected crashes occurred during afternoon or evening times. In terms of the day of week (categorized as either weekday or weekend), about three-fourths of total teenage and young-adult drivers' distraction-affected crashes happened on weekdays, whereas about one-fourth of total teenage and young-adult drivers' distraction-affected crashes happened during weekends.

3.2.3.7 Contributory Causes

Three contributory causes (i.e., environmental, vehicle, and road factors) are shown in Table 3.9. Environmental factors were coded into three categories (levels), which include animal, weather, and vision obstruction related factors, and their frequencies of occurrences were analyzed and the data show that they were 2.3%, 0.9%, and 0.2%, respectively of total teenage drivers' distraction-affected crashes and 2.4%, 0.9%, and 0.2%, respectively of total young-adult drivers' distraction-affected crashes. In terms of vehicle and road factors, only 0.7% of total teenage and young-adult drivers' distraction-affected crashes occurred when the vehicle factors were related, and 3.5% of total teenage and young-adult drivers' distraction-affected crashes took place when the road factors were related.

Table 3.9 Crash Frequencies and Percentages by Teenage and Young-Adult Distracted Drivers: Environmental, Vehicle, and Road Factors for Period of (2011-2015)

Contributory Causes	Teenage Drivers		Young-adult Drivers	
	Number	%	Number	%
Animal	321	2.3%	261	2.4%
Weather related	122	0.9%	97	0.9%
Vision obstruction	22	0.2%	17	0.2%
Total Crashes Occurred Due to Environmental Factors	465	3.3%	375	3.4%
Total Crashes Occurred Due to Vehicle Factors	92	0.7%	77	0.7%
Total Crashes Occurred Due to Road Factors	492	3.5%	388	3.5%

3.2.4 Results of Crash Type Models

3.2.4.1 Collinearity Analysis for Teenage Drivers

As the first step, a Correlation Matrix was developed to detect highly correlated explanatory variables which is shown in Appendix A.1. By running twenty-two models one of the correlated variables that causes to increase AIC and SC values was removed from the model one at a time while keeping everything else constant.

There were 11 highly correlated pairs in teenage drivers' distraction-affected crash data set which included: non-incapacitating injury/possible injury and not injured, concrete and black top road surface type, wet/debris road surface condition and adverse weather conditions, speed limit less than 35 mph and speed limit 35-60 mph, if driven with passengers and if driven with teenage front-seat passengers, on roadway and at intersection crash, straight-following and turn or changing lanes maneuver, vehicle age (11-15 years) and older than 15 years, night and no daylight, automobile and pickup-truck/camper-rv, and automobile and sport utility vehicle. Among these highly correlated pairs, variables of not injured, concrete road surface type, wet/debris road surface condition, speed limit less than 35 mph, driving with teenage front-seat passengers, at intersection crash, changing lanes maneuver, vehicle age older than 15 years, no daylight, pickup-truck/camper-rv, and sport utility vehicle, were included in the final model as shown in Table 3.10.

Table 3.10 Collinearity Analysis for Teenage Drivers' Crash Type Model

Variable 1	Variable 2	Correlation Coefficient	Variables Considered to be Included in the Model
Non-incapacitating injury /possible injury	Not injured	-0.923	Not injured
Concrete road surface type	Black top road surface type	-0.873	Concrete road surface type
Wet/debris road surface condition	Adverse weather conditions	0.786	Wet/debris road surface condition
Speed limit less than 35 mph	Speed limit 35-60 mph	-0.778	Speed limit less than 35 mph
If driven with passengers	If driven with teenage front-seat passengers	0.736	If drive with teenage front-seat passengers
On roadway crash	At intersection crash	-0.721	At intersection crash
Straight-following maneuver	Turn or changing lanes maneuver	-0.717	Turn or changing lanes maneuver
Vehicle Age (11-15 years)	Vehicle age older than 15 years	-0.685	Vehicle age older than 15 years
Night	No daylight	0.654	No daylight
Automobile	Pickup-truck, camper-rv	-0.605	Pickup-truck, camper-rv
Automobile	Sport utility vehicle	-0.602	Sport utility vehicle

3.2.4.2 Multinomial Logistic Regression Model Results for Teenage Drivers

A multinomial logit model procedure in SAS software (version 9.4) was used to determine how different distraction types affect the most common crash types among teenage drivers (15–20 year old). The total dataset contained 13,949 observations of teenage drivers' distraction-affected crashes that occurred between 2011 and 2015. In this model, crash type was the dependent variable, which consisted of three crash types rear-end, angular, and single-vehicle crashes which were the most common types. All variables that are depicted in Tables 3.3 through 3.9 and their interactions with distraction types were included in the model as predictor variables. All of these predictor variables were coded as dummy variables. However, predictor variables that have no significant differences in crash type were removed from the final teenage drivers' model by

using stepwise selection model. The predictor variables of final teenage drivers' model are presented in Tables 3.11 through 3.14.

Each predictor variable has confidence estimate, standard error, Chi Square, and p-value as shown in Tables 3.11 and 3.13. The standard error for each predictor variable is used to calculate p-value of particular predictor variables. The smallest p-value means this predictor variables significantly improved the overall model fitting. Additionally, odds ratio and confidence interval estimates for each predictor variable are estimated in the model as shown in Tables 3.12 and 3.14. Moreover, the overall model fit statistics had a Likelihood Ratio of 14,286, whose p-value is < 0.0001. This means that teenage drivers' model fits the data well.

Table 3.11 Likelihood of Different Types of Crashes Based on Teenage Drivers Distraction for Distraction Types and their Interaction with Other Factors

Variable	Rear-End Crash Versus Single-Vehicle Crash				Angular Crash Versus Single-Vehicle Crash				Rear-End Crash Versus Angular Crash			
	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq
Intercept	-2.25	0.34	43.30	<.0001	-4.20	0.41	105.13	<.0001	1.96	0.36	28.83	<.0001
Cell phone	1.44	0.32	19.81	<.0001	1.06	0.48	4.79	0.0286	0.38	0.47	0.66	0.4161
Other electronic devices	1.97	0.31	40.18	<.0001	1.77	0.40	19.18	<.0001	0.21	0.36	0.34	0.5611
In/on-vehicle distraction	2.16	0.22	96.36	<.0001	1.46	0.32	21.23	<.0001	0.70	0.30	5.34	0.0209
External distraction	3.67	0.45	66.39	<.0001	1.45	0.55	6.98	0.0082	2.21	0.42	27.75	<.0001
Inattention	2.49	0.19	180.04	<.0001	2.61	0.28	87.63	<.0001	-0.13	0.28	0.20	0.6523
Cell phone use*Speed Limit>60 mph	0.41	0.63	0.41	0.5196	1.62	0.67	5.90	0.0152	-1.22	0.57	4.60	0.0319
Cell phone use*At Intersection	0.90	0.43	4.33	0.0374	1.53	0.51	8.86	0.0029	-0.63	0.41	2.41	0.1208
Cell phone use*21.00-5.00-Night	-1.46	0.49	8.91	0.0028	-1.30	0.55	5.54	0.0186	-0.16	0.50	0.10	0.7504
Other Electronic Devices* Teenage front-seat passengers	-1.67	0.53	10.12	0.0015	-1.06	0.63	2.83	0.0927	-0.61	0.52	1.38	0.2397
In/On-vehicle distraction* Teenage front-seat passengers	-0.58	0.26	4.97	0.0258	0.29	0.29	0.95	0.3303	-0.87	0.22	15.02	0.0001
External distraction*Speed limit<35 mph	-1.25	0.59	4.55	0.0328	0.53	0.63	0.70	0.4023	-1.78	0.44	16.12	<.0001
External distraction*Rural roads	-1.28	0.69	3.45	0.0634	0.89	0.69	1.67	0.1965	-2.17	0.60	12.97	0.0003
Inattention*21.00-5.00-Night	-0.66	0.25	6.77	0.0093	-1.12	0.29	15.15	<.0001	0.47	0.28	2.84	0.0919

Table 3.12 Odds Ratio Estimates of Occurrence of Different Types of Crashes Based on Teenage Driver Distraction for Distraction Types and their Interaction with Other Factors

Variable	Rear-End Crash Versus Single-Vehicle Crash			Angular Crash Versus Single-Vehicle Crash			Rear-End Crash Versus Angular Crash		
	Point Estimate	95% Confidence Limits		Point Estimate	95% Confidence Limits		Point Estimate	95% Confidence Limits	
Cell phone	4.21	2.24	7.92	2.87	1.12	7.40	n.s.; 1.46	0.58	3.67
Other electronic devices	7.20	3.91	13.25	5.85	2.65	12.89	n.s.; 1.23	0.61	2.48
In/on-vehicle distraction	8.71	5.65	13.42	4.32	2.32	8.06	2.02	1.11	3.65
External distraction	39.08	16.18	94.37	4.27	1.46	12.54	9.15	4.02	20.85
Inattention	12.04	8.37	17.32	13.65	7.90	23.60	n.s.; 0.88	0.51	1.52
Cell phone use*Speed Limit>60 mph	n.s.; 1.50	0.44	5.16	5.07	1.37	18.80	0.30	0.10	0.90
Cell phone use*At Intersection	2.45	1.05	5.69	4.60	1.68	12.55	n.s.; 0.53	0.24	1.18
Cell phone use*21.00-5.00-Night	0.23	0.09	0.61	0.27	0.09	0.81	n.s.; 0.85	0.32	2.28
Other Electronic Devices* Teenage front-seat passengers	0.19	0.07	0.53	n.s.; 0.35	0.10	1.19	n.s.; 0.54	0.20	1.50
In/On-vehicle distraction* Teenage front-seat passengers	0.56	0.33	0.93	n.s.; 1.33	0.75	2.37	0.42	0.27	0.65
External distraction*Speed limit<35 mph	0.29	0.09	0.90	n.s.; 1.69	0.49	5.80	0.17	0.07	0.40
External distraction*Rural roads	n.s.; 0.28	0.07	1.07	n.s.; 2.44	0.63	9.42	0.12	0.04	0.37
Inattention*21.00-5.00-Night	0.52	0.32	0.85	0.33	0.19	0.57	n.s.; 1.60	0.93	2.75

Note: n.s. indicates no significance found at α= 0.05 level.

The main purpose of this model was to evaluate whether different teenage driver distractions would affect the most common crash types. The model results showed that most teenage driver distractions were more likely to be involved in rear-end collisions or angular collisions when compared to single-vehicle crashes. However, the model results showed that no significant difference was observed between rear-end collisions and angular collisions for teenage drivers distracted by cell phones or other electronic devices, or who were inattentive.

In regards to interaction terms, model results indicated that teenage drivers who were distracted by cell phones while driving on roads with speed limit more than 60 mph were more probable to be involved in an angular collision when compared to both a single-vehicle crash (OR=5.07) or a rear-end collision (OR=3.33). In contrast, if teenage drivers distracted by cell phones at intersections, they were more probable to be involved in a rear-end collision (OR=2.45) or an angular collision (OR=4.60) when compared to a single-vehicle crash. Opposite

trend in probability of a specific collision was also observed when teenage drivers drove at nighttime and distracted by cell phones. If teenage drivers drove with teenage front-seat passengers and distracted by other electronic devices, they were less likely to be involved in a rear-end collision when compared to a single-vehicle crash. Also, when these teenage drivers drove with their peers as front-seat passengers and distracted inside the vehicle, they were less likely to be involved in a rear-end collision when compared to both a single-vehicle crash (OR=0.56) or an angular crash (OR=0.42). Likewise, on roads with speed limit less than 35 mph, external distracted teenage drivers are more than five times more likely to be involved in an angular crash than a rear-end crash and more than three times more likely to be involved in a single-vehicle crash than a rear-end crash. The model findings indicated that no significant effects were found for a rear-end collision and an angular collision when they are compared to a single-vehicle crash for teenage drivers distracted on rural roads by external distractions. For these teenage drivers, the odds of being involved in an angular collision was 8.33 times higher than that of a rear-end collision. Moreover, the model findings showed that when teenage drivers were inattentive at nighttime, the odds of a rear-end collision over a single- vehicle collision, and an angular collision over a single-vehicle crash are decreased (OR=0.52, 0.33, respectively).

Table 3.13 Likelihood of Different Types of Crashes Based on Teenage Driver Distraction for Other Factors

Variable	Rear-End Crash Versus Single-Vehicle Crash				Angular Crash Versus Single-Vehicle Crash				Rear-End Crash Versus Angular Crash			
	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq
Valid licensed	0.88	0.14	36.81	<.0001	0.49	0.15	10.38	0.0013	0.39	0.11	12.63	0.0004
Vehicle age (Year 5 or newer)	0.75	0.25	9.00	0.0027	0.74	0.26	8.40	0.0038	0.01	0.15	0.01	0.9387
Vehicle age (6-10 years)	0.24	0.12	3.87	0.0492	0.41	0.13	10.29	0.0013	-0.17	0.08	4.67	0.0306
Sport utility vehicle	0.12	0.12	0.98	0.3213	-0.11	0.12	0.85	0.3561	0.23	0.08	8.27	0.004
Turn/changing lanes maneuver	-2.23	0.12	323.30	<.0001	1.22	0.11	119.73	<.0001	-3.45	0.08	1,738.60	<.0001
Avoiding maneuver	-0.96	0.24	16.74	<.0001	-0.50	0.27	3.45	0.0633	-0.46	0.21	4.75	0.0293
Stopped/parking/backing maneuver	1.10	0.23	22.24	<.0001	0.60	0.25	5.72	0.0168	0.50	0.12	16.71	<.0001
No damage	2.03	0.52	15.17	<.0001	0.01	0.61	0.00	0.9882	2.02	0.39	26.62	<.0001
Minor damage	1.76	0.13	175.67	<.0001	1.08	0.14	60.78	<.0001	0.68	0.08	75.39	<.0001
Functional damage	1.20	0.10	132.06	<.0001	0.96	0.11	77.12	<.0001	0.24	0.07	12.15	0.0005
Destroyed damage	-0.61	0.14	18.39	<.0001	-0.25	0.16	2.61	0.106	-0.36	0.14	6.79	0.0092
Teenage front-seat passengers	-0.13	0.10	1.83	0.1764	0.15	0.10	2.03	0.1546	-0.28	0.06	18.33	<.0001
Female driver	0.16	0.08	3.55	0.0596	0.25	0.09	7.88	0.005	-0.09	0.06	2.54	0.1113
Driver safety belt used	0.47	0.14	10.57	0.0011	0.66	0.16	17.68	<.0001	-0.20	0.13	2.30	0.1295
Ejected	-0.69	0.62	1.27	0.2607	0.92	0.51	3.32	0.0685	-1.62	0.56	8.46	0.0036
Trapped	-0.65	0.50	1.67	0.1963	0.78	0.45	2.92	0.0877	-1.43	0.48	8.66	0.0032
Not injured	0.61	0.11	30.82	<.0001	0.12	0.12	0.99	0.3189	0.49	0.09	29.38	<.0001
Speed limit<35 mph	-0.95	0.09	103.10	<.0001	0.38	0.10	14.92	0.0001	-1.33	0.06	477.84	<.0001
Speed limit>60 mph	-0.05	0.13	0.15	0.7013	-0.60	0.16	14.47	0.0001	0.55	0.13	18.04	<.0001
Concrete road surface type	-0.25	0.10	6.57	0.0104	-0.33	0.10	10.23	0.0014	0.09	0.07	1.63	0.2012
Gravel/brick road surface type	-2.26	0.18	157.79	<.0001	-1.20	0.17	49.24	<.0001	-1.06	0.17	38.81	<.0001
Curved road	-2.04	0.14	211.15	<.0001	-1.91	0.17	132.48	<.0001	-0.13	0.15	0.78	0.3762
Work zone related	0.89	0.28	9.89	0.0017	-0.33	0.34	0.97	0.3249	1.22	0.23	27.72	<.0001
Multi-lanes road	0.58	0.20	8.54	0.0035	0.24	0.20	1.39	0.2388	0.34	0.16	4.72	0.0298
5.00-9.00-Morning	-0.23	0.12	3.74	0.0531	-0.33	0.13	6.22	0.0126	0.09	0.09	1.11	0.2924

Table 3.13 Likelihood of Different Types of Crashes Based on Teenage Driver Distraction for Other Factors (continued)

Variable	Rear-End Crash Versus Single-Vehicle Crash				Angular Crash Versus Single-Vehicle Crash				Rear-End Crash Versus Angular Crash			
	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq
13.00-17.00-Afternoon	0.69	0.10	44.04	<.0001	0.38	0.11	12.18	0.0005	0.31	0.06	24.00	<.0001
21.00-5.00-Night	-1.12	0.22	25.39	<.0001	-0.40	0.26	2.43	0.1188	-0.71	0.25	8.12	0.0044
Weekend	-0.78	0.09	72.13	<.0001	-0.41	0.10	17.78	<.0001	-0.37	0.07	27.06	<.0001
At Intersection	1.06	0.09	135.63	<.0001	2.12	0.10	456.48	<.0001	-1.05	0.07	261.38	<.0001
Off-roadway crash	-5.54	0.20	789.80	<.0001	-3.07	0.16	376.20	<.0001	-2.48	0.23	115.08	<.0001
Rural roads	-1.27	0.10	154.62	<.0001	-0.22	0.11	4.22	0.04	-1.05	0.08	170.50	<.0001
Vehicle factors	-1.34	0.38	12.16	0.0005	-1.58	0.46	12.10	0.0005	0.24	0.37	0.43	0.5106
Number of observations	13,949											
AIC	13,056.73											
SC	13,750.70											
-2 Log L	12,872.73											
Likelihood Ratio	14,286.97			<.0001								
Score	13,693.75			<.0001								

Table 3.14 Odds Ratio Estimates of Occurrence of Different Types of Crashes Based on Teenage Driver Distraction for Other Factors

Variable	Rear-End Crash Versus Single-Vehicle Crash			Angular Crash Versus Single-Vehicle Crash			Rear-End Crash Versus Angular Crash		
	Point Estimate	95% Confidence Limits		Point Estimate	95% Confidence Limits		Point Estimate	95% Confidence Limits	
Valid licensed	2.41	1.81	3.20	1.63	1.21	2.19	1.48	1.19	1.84
Vehicle age (Year 5 or newer)	2.13	1.30	3.48	2.10	1.27	3.47	n.s.; 1.01	0.75	1.37
Vehicle age (6-10 years)	1.27	1.00	1.61	1.50	1.17	1.93	0.84	0.72	0.98
Sport utility vehicle	n.s.; 1.12	0.89	1.41	n.s.; 0.89	0.70	1.14	1.26	1.08	1.47
Turn/changing lanes maneuver	0.11	0.09	0.14	3.39	2.72	4.21	0.03	0.03	0.04
Avoiding maneuver	0.38	0.24	0.61	n.s.; 0.61	0.36	1.03	0.63	0.42	0.96
Stopped/parking/backing maneuver	3.00	1.90	4.74	1.81	1.11	2.96	1.66	1.30	2.11
No damage	7.63	2.74	21.20	n.s.; 1.01	0.31	3.31	7.56	3.51	16.30
Minor damage	5.79	4.47	7.51	2.94	2.24	3.85	1.97	1.69	2.30
Functional damage	3.31	2.70	4.06	2.62	2.11	3.24	1.27	1.11	1.44
Destroyed damage	0.54	0.41	0.72	n.s.; 0.78	0.57	1.06	0.70	0.54	0.92
Teenage front-seat passengers	n.s.; 0.88	0.72	1.06	n.s.; 1.16	0.95	1.41	0.76	0.67	0.86
Female driver	n.s.; 1.17	0.99	1.37	1.28	1.08	1.52	n.s.; 0.91	0.82	1.02
Driver safety belt used	1.59	1.20	2.11	1.94	1.42	2.64	n.s.; 0.82	0.64	1.06
Ejected	n.s.; 0.50	0.15	1.67	n.s.; 2.52	0.93	6.81	0.20	0.07	0.59
Trapped	n.s.; 0.52	0.19	1.40	n.s.; 2.17	0.89	5.30	0.24	0.09	0.62
Not injured	1.85	1.49	2.29	n.s.; 1.13	0.89	1.42	1.64	1.37	1.96
Speed limit<35 mph	0.39	0.32	0.46	1.46	1.20	1.76	0.26	0.24	0.30
Speed limit>60 mph	n.s.; 0.95	0.74	1.23	0.55	0.40	0.75	1.74	1.35	2.24
Concrete road surface type	0.78	0.65	0.94	0.72	0.59	0.88	n.s.; 1.09	0.96	1.24
Gravel/brick road surface type	0.10	0.07	0.15	0.30	0.22	0.42	0.35	0.25	0.48
Curved road	0.13	0.10	0.17	0.15	0.11	0.21	n.s.; 0.88	0.65	1.18
Work zone related	2.43	1.40	4.24	n.s.; 0.72	0.37	1.39	3.39	2.15	5.34
Multi-lanes road	1.78	1.21	2.63	n.s.; 1.27	0.85	1.89	1.40	1.03	1.90
5.00-9.00-Morning	n.s.; 0.79	0.63	1.00	0.72	0.56	0.93	n.s.; 1.10	0.92	1.31
13.00-17.00-Afternoon	1.99	1.62	2.43	1.46	1.18	1.81	1.36	1.20	1.54
21.00-5.00-Night	0.33	0.21	0.51	n.s.; 0.67	0.40	1.11	0.49	0.30	0.80
Weekend	0.46	0.38	0.55	0.66	0.55	0.80	0.69	0.60	0.80
At Intersection	2.90	2.42	3.46	8.30	6.83	10.07	0.35	0.31	0.40
Off roadway crash	0.00	0.00	0.01	0.05	0.03	0.06	0.08	0.05	0.13
Rural roads	0.28	0.23	0.34	0.80	0.65	0.99	0.35	0.30	0.41
Vehicle factors	0.26	0.12	0.56	0.21	0.08	0.50	n.s.; 1.28	0.62	2.63

Note: n.s. indicates no significance found at $\alpha = 0.05$ level.

Distracted teenage drivers' model exhibited that valid licensed drivers, stopped/parking/ backing maneuver, afternoon driving, involving in minor vehicle damage crash, and involving in functional vehicle damage crash, have similar effects on teenage drivers' collision types. In particular, all these variables contributed to increase the odds of rear-end collisions or angular collisions when compared to single-vehicle crashes (OR=2.41 and 1.63 for valid licensed; 3.00 and 1.81 for stopped/parking/backing maneuver; 1.99 and 1.46 for afternoon driving; 5.79 and 2.94 for minor vehicle damage crash; 3.31 and 2.62 for functional vehicle damage crash). Additionally, they contributed to increase the odds of rear-end collisions when compared to angular collisions (OR=1.48; 1.66; 1.36; 1.97; 1.27, respectively). Driving on gravel/brick road surface type, driving on weekend, off roadway crash, and driving on rural roads have also similar effects on teenage drivers' collision types. However, they contributed to decreased the odds of rear-end collisions or angular collisions when compared to single-vehicle crashes (OR=0.11 and 0.30 for gravel/brick road surface type; 0.46 and 0.66 for weekend; 0.00 and 0.05 for off roadway crash; 0.28 and 0.80 for rural roads). Also, those contributed to decreased the odds of rear-end collisions when compared to angular collisions (OR=0.35; 0.69; 0.08; 0.35, respectively).

At an intersection, teenage drivers were more likely to be involved in both a rear-end crash or an angular crash when compared to a single-vehicle crash. However, they were less likely to be involved in a rear-end crash when compared to an angular crash. Similar trend in probability of a specific collision was also observed when teenage drivers drove vehicle age between 6 to 10 years old. The model findings showed that when teenage drivers turned or changed lanes maneuver or drove on roads with speed limit less than 35 mph were more likely to be involved in single-vehicle crashes or angular crashes when compared to rear-end crashes

(OR=9.09 and 33.33 for turned or changed lanes maneuver; 2.56 and 3.84 for speed limit less than 35 mph). Moreover, they were more likely to be involved in angular crashes when compared to single-vehicle crashes (OR=3.39 for turned or changed lanes maneuver; 1.46 for speed limit less than 35 mph).

The model results showed that when teenage drivers avoided maneuver or drove at night were more likely to be involved in single-vehicle crashes or angular crashes when compared to rear-end crashes (OR=2.63 and 1.58 for avoiding maneuver; 3.03 and 2.04 for driving at night). Similar trend in probability of particular collisions was also detected when teenage drivers involved in destroyed vehicle damage crash. However, when teenage drivers' crashes work zone related, they were more likely to be involved in rear-end crashes when compared to both single-vehicle crashes (OR = 2.43) or angular crashes (OR = 3.39). Also, similar trend in probability of particular collisions was also detected when teenage drivers involved in no damage vehicle crash, suffered not injured due to crash, and drove on multi-lanes road. Teenage drivers safety belt used were more likely to be involved in a rear-end collision or an angular collision when compared to a single-vehicle crash. Also, teenage drivers who drove new vehicles were more likely to be involved in a rear-end collision or an angular collision when compared to a single vehicle collision. However, reverse trend in probability of a particular collision was observed when teenage drivers drove on concrete roads surface or on curved roads. Furthermore, when vehicle factors involved in teenage drivers' crashes, the odds of a single-vehicle crash was almost 4 times higher than a rear-end crash and an angular crash. When teenage drivers drove on roads with speed limit more 60 mph, they were more likely to be involved in a single-vehicle crash (OR = 1.81) or a rear-end crash (OR = 1.74) when compared to an angular crash.

The model results showed that teenage female drivers were more likely to be involved in an angular crash when compared to a single-vehicle crash (OR=1.28). However, reverse trend in probability of a particular collision was detected when teenage drivers drove in the morning. Also, the results showed that when teenage drivers drove with their peers as front-seat passengers or were ejected or trapped due to crash, they were more likely to be involved in angular crashes when compared to rear-end crashes (OR=1.31; 5.00; 4.16, respectively). However, teenage drivers who drove sport utility vehicles were more likely to be involved in rear-end crashes when compared to angular crashes (OR=1.26).

Teenage drivers' model with and without 2-way interaction were compared using the AIC, SC, and -2 Log L values. Table 11 shows three different "Model Fit Statistics:" AIC, SC, and -2 Log L. Values of these fit statistics are displayed for two different models, a model with an intercept but no covariates (predictors), and a model that includes all the specified predictors (covariates). However, AIC, SC, and -2 Log L statistics of intercept and covariates are usually used to compare different models fit to the same data set. A small value of intercept and covariates indicates the best model compared to the other model. In this study, it clear to show that the teenage drivers' model with 2-way interaction is the best model when compared to the teenage drivers' model without 2-way interaction model because this model has the lowest value of AIC, SC, and -2 Log L (13,056.73; 13,750.70; 12,872.73, respectively). Based on this statistical evidence, it can be concluded that, in general, the interaction terms statistically improve the overall fit of the teenage driver's model.

Table 3.15 Comparison of Statistically Models Fit of Teenage Drivers' Crash Type Model with and without 2-Way Interaction

Criterion	Teenage Drivers' Crash Type Model with 2-Way Interaction		Teenage Drivers' Crash Type Model without 2-Way Interaction	
	Intercept Only	Intercept and Covariates	Intercept Only	Intercept and Covariates
AIC	27,163.70	13,056.73	27,163.70	13,132.06
SC	27,178.79	13,750.70	27,178.79	13,916.54
-2 Log L	27,159.70	12,872.73	27,159.70	12,924.06

3.2.4.3 Collinearity Analysis for Young-Adult Drivers

As shown in Table 3.16, there were 7 highly correlated pairs in young-adult drivers' distraction data set which included: concrete road and black top road surface type, injury - not incapacitating /possible injury and not injured, wet/debris surface condition and adverse weather conditions, on roadway and at intersection crash, speed limit less than 35 mph and speed limit 35-60 mph, straight-following maneuver and turn or changing lanes maneuver, and night and no daylight. Among these highly correlated pairs, variables of concrete road surface type, not injured, wet/debris road surface condition, at intersection crash, speed limit less than 35 mph, turn or changing lanes maneuver, and no daylight, were included in the final model. The Correlation Matrix is provided in Appendix A.2.

Table 3.16 Collinearity Analysis Variables for Young-Adult Drivers' Crash Type Model

Variable 1	Variable 2	Correlation Coefficient	Variables Considered to be Included in the Model
Concrete road surface type	Black top road surface type	-0.916	Concrete road surface type
Non-incapacitating injury/Possible injury	Not injured	-0.896	Not injured
Wet/Debris surface condition	Adverse weather conditions	0.782	Wet/debris road surface condition
On roadway crash	At intersection crash	-0.731	At intersection crash
Speed limit less than 35 mph	Speed limit 35-60 mph	-0.718	Speed limit less than 35 mph
Straight-following maneuver	Turn or changing lanes maneuver	-0.691	Turn or changing lanes maneuver
Night	No daylight	0.673	No daylight

3.2.4.4 Multinomial Logistic Regression Model Results for Young-Adult Drivers

A multinomial logit model procedure in SAS software (version 9.4) was used to determine how different distraction types affect the most common crash types (rear-end, angular, and single-vehicle crashes) among young-adult drivers (21–26 years old). The total dataset contained 11,084 observations of young-adult drivers' distraction-affected crashes that occurred between 2011 and 2015. In this model, the crash type was the dependent variable. All variables that depicted in Tables 3.3 through 3.9 and their interactions with distraction types were included in the model as predictor variables. All of these predictor variables were coded as dummy variables. However, predictor variables that have no significant differences in crash type were removed from the final young-adult drivers' model by using stepwise selection model. The predictor variables of final young-adult drivers' model are presented in Tables 3.17 through 3.20.

Each predictor variables has confidence estimate, standard error, Chi Square, and p-value as shown in Tables 3.17 and 3.19. The standard error value for each predictor variable is used to

calculate p-value of particular predictor variables. The smallest p-value means this predictor variables significantly improved the overall model fitting. Additionally, odds ratio and confidence interval estimates for each predictor variable are estimated in the model as shown in Tables 3.18 and 3.20. Moreover, the overall model fit statistics had a Likelihood Ratio of 10,525, whose p-value is < 0.0001, indicating that young-adult drivers' model fits the data well.

Table 3.17 Likelihood of Different Types of Crashes Based on Young-Adult Driver Distraction for Distraction Types and their Interaction with Other Factors

Variable	Rear-End Crash Versus Single-Vehicle Crash				Angular Crash Versus Single-Vehicle Crash				Rear-End Crash Versus Angular Crash			
	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq
Intercept	-1.86	0.34	30.85	<.0001	-4.19	0.43	97.03	<.0001	2.33	0.37	39.65	<.0001
Cell phone use	2.15	0.39	30.36	<.0001	1.67	0.56	8.94	0.0028	0.49	0.52	0.89	0.3458
Other electronic devices	1.88	0.33	32.18	<.0001	1.85	0.43	18.59	<.0001	0.04	0.36	0.01	0.9192
In/on-vehicle distraction	2.94	0.52	31.83	<.0001	2.54	0.61	17.29	<.0001	0.40	0.48	0.69	0.4068
External distraction	3.57	0.40	78.39	<.0001	2.50	0.48	27.26	<.0001	1.08	0.34	9.84	0.0017
Inattention	2.24	0.20	130.34	<.0001	2.55	0.29	76.30	<.0001	-0.32	0.28	1.30	0.254
Cell phone use* vehicle age (Year 16 or older)	-0.99	0.42	5.60	0.018	-0.09	0.45	0.04	0.8494	-0.90	0.31	8.35	0.0039
Cell phone use*Sport utility vehicle	-1.28	0.52	6.06	0.0138	-1.48	0.58	6.51	0.0107	0.20	0.43	0.20	0.6513
Cell phone use*Turn/Changing lanes maneuver	-1.95	0.84	5.43	0.0197	-1.78	0.68	6.88	0.0087	-0.17	0.72	0.06	0.8123
Cell phone use*Curved road	-2.15	0.83	6.63	0.01	0.03	0.79	0.00	0.973	-2.18	0.89	6.04	0.014
Cell phone use*At intersection	0.83	0.44	3.58	0.0584	1.59	0.55	8.30	0.004	-0.75	0.46	2.74	0.098
In/on-vehicle distraction*Valid licensed	-1.38	0.51	7.40	0.0065	-1.64	0.55	8.79	0.003	0.26	0.37	0.49	0.4837
In/on-vehicle distraction*Concrete road surface type	0.48	0.32	2.18	0.1394	0.95	0.37	6.63	0.01	-0.47	0.23	4.00	0.0454
In/On-vehicle distraction*Curved Road	-1.40	0.47	8.68	0.0032	-0.07	0.64	0.01	0.918	-1.33	0.60	4.87	0.0274
In/On-vehicle distraction*At intersection	0.44	0.30	2.15	0.1429	1.06	0.37	8.36	0.0038	-0.62	0.27	5.32	0.021
Inattention*Speed limit>60 mph	-0.84	0.25	11.17	0.0008	-0.81	0.35	5.38	0.0204	-0.04	0.30	0.02	0.9007
Inattention*weekend	0.50	0.22	5.43	0.0198	0.07	0.25	0.07	0.7913	0.44	0.19	5.44	0.0197

Table 3.18 Odds Ratio Estimates of Occurrence of Different Types of Crashes Based on Young-Adult Driver Distraction for Distraction Types and their Interaction with Other Factors

Variable	Rear-End Crash Versus Single-Vehicle Crash			Angular Crash Versus Single-Vehicle Crash			Rear-End Crash Versus Angular Crash		
	Point Estimate	95% Confidence Limits		Point Estimate	95% Confidence Limits		Point Estimate	95% Confidence Limits	
Cell phone use	8.59	4.00	18.47	5.29	1.77	15.75	n.s.; 1.63	0.59	4.46
Other electronic devices	6.58	3.43	12.63	6.35	2.74	14.70	n.s.; 1.04	0.51	2.11
In/on-vehicle distraction	18.98	6.83	52.77	12.72	3.84	42.19	n.s.; 1.49	0.58	3.84
External distraction	35.54	16.12	78.34	12.13	4.75	30.95	2.93	1.50	5.74
Inattention	9.36	6.38	13.74	12.86	7.25	22.80	n.s.; 0.73	0.42	1.26
Cell phone use* vehicle age (Year 16 or older)	0.37	0.16	0.84	n.s.; 0.92	0.38	2.24	0.41	0.22	0.75
Cell phone use*Sport utility vehicle	0.28	0.10	0.77	0.23	0.07	0.71	n.s.; 1.22	0.52	2.85
Cell phone use*Turn/Changing lanes maneuver	0.14	0.03	0.73	0.17	0.04	0.64	n.s.; 0.84	0.21	3.46
Cell phone use*Curved road	0.12	0.02	0.60	n.s.; 1.03	0.22	4.85	0.11	0.02	0.64
Cell phone use*At intersection	n.s.; 2.30	0.97	5.46	4.90	1.66	14.44	n.s.; 0.47	0.19	1.15
In/on-vehicle distraction*Valid licensed	0.25	0.09	0.68	0.19	0.07	0.57	n.s.; 1.30	0.63	2.67
In/on-vehicle distraction*Concrete road surface type	n.s.; 1.61	0.86	3.04	2.58	1.25	5.30	0.63	0.40	0.99
In/On-vehicle distraction*Curved Road	0.25	0.10	0.63	n.s.; 0.94	0.27	3.30	0.26	0.08	0.86
In/On-vehicle distraction*At intersection	n.s.; 1.56	0.86	2.81	2.88	1.41	5.90	0.54	0.32	0.91
Inattention*Speed limit>60 mph	0.43	0.26	0.71	0.45	0.23	0.88	n.s.; 0.96	0.54	1.73
Inattention*weekend	1.66	1.08	2.53	n.s.; 1.07	0.65	1.75	1.55	1.07	2.24

Note: n.s. indicates no significance found at α= 0.05 level.

The major purpose of young-adult drivers' model was also to evaluate whether different distraction types would affect the crash types. It is clear that there is no considerable difference between this model and the previous model. This model results showed that most young-adult driver distractions were more likely to be involved in rear-end collisions or angular collisions when compared to single-vehicle crashes. However, the results showed that no significant difference was detected between rear-end collisions and angular collisions for young-adult drivers distracted by cell phones, other electronic devices, or in/on vehicle or who were inattentive.

In regards to interaction terms, this model results indicated that no significant effects are found for a rear-end collision when it is compared to an angular collision for young-adult drivers

distracted by cell phones when they turned or changed lanes maneuver. For these young-adult drivers, the odds of being involved in a single-vehicle crash was almost six times greater than a rear-end collision and an angular collision. In addition, if young-adult drivers drove sport vehicle and distracted by cell phones, the odds of being involved in a single-vehicle crash was almost four times greater than a rear-end collision and an angular collision. Young-adult drivers held a valid license and distracted inside the vehicle, they were also more likely to be involved in a single-vehicle crash when compared to a rear-end crash (OR=4.00) or an angular crash (OR=5.26). Similar trend in probability of a specific collision was also detected when young-adult drivers were inattentive on roads with speed limit more than 60 mph. Young-adult drivers that were distracted on curved roads by cell phones or inside the vehicle were less likely to be involved in a rear-end collision when compared to a single-vehicle crash or an angular collision (OR=0.12 and 0.11 for cell phones; 0.25 and 0.26 for inside the vehicle). Likewise, when young-adult drivers drove old vehicles and distracted by cell phones, they were less likely to be involved in a rear-end collision when compared to a single-vehicle crash (OR=0.37) or an angular collision (OR=0.41). However, reverse trend in probability of a specific collision was observed when young-adult drivers were inattentive on the weekend.

Young-adult drivers that were distracted at intersections by cell phone or inside the vehicle were more probable to be involved in angular crashes when compared to single-vehicle crashes (OR=4.90; 2.88, respectively). Moreover, when young-adult drivers distracted inside the vehicle at intersections, they were more likely to be involved in an angular crash when compared to a rear-end crash (OR=1.85). Also, the model findings showed that when young-adult drivers distracted on concrete roads surface by inside the vehicle, they were more probable to be

involved in an angular collision when compared to a single-vehicle crash (OR=2.58) or a rear-end collision (OR=1.58).

Table 3.19 Likelihood of Different Types of Crashes Based on Young-Adult Driver Distraction for Other Factors

Variable	Rear-End Crash Versus Single-Vehicle Crash				Angular Crash Versus Single-Vehicle Crash				Rear-End Crash Versus Angular Crash			
	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq
Valid licensed	0.58	0.13	19.24	<.0001	0.50	0.15	11.97	0.0005	0.08	0.10	0.55	0.458
Alcohol/drug related	-0.82	0.18	21.77	<.0001	-1.41	0.23	38.11	<.0001	0.59	0.22	7.14	0.0076
Pickup-truck/camper-rv	-0.32	0.12	6.68	0.0098	-0.10	0.13	0.54	0.4618	-0.22	0.09	6.67	0.0098
Turn/changing lanes maneuver	-1.53	0.13	133.14	<.0001	1.33	0.13	108.19	<.0001	-2.86	0.08	1,163.38	<.0001
Avoiding maneuver	-1.08	0.23	21.78	<.0001	-0.29	0.27	1.16	0.2823	-0.79	0.20	15.13	0.0001
Stopped/Parking/backing maneuver	0.78	0.22	12.21	0.0005	0.10	0.25	0.16	0.6938	0.68	0.15	21.92	<.0001
No damage	0.96	0.40	5.75	0.0165	-0.62	0.47	1.74	0.1878	1.58	0.32	23.71	<.0001
Minor damage	1.72	0.14	141.72	<.0001	0.99	0.15	40.72	<.0001	0.74	0.09	74.41	<.0001
Functional damage	1.09	0.11	94.26	<.0001	0.81	0.12	44.75	<.0001	0.28	0.08	13.34	0.0003
Destroyed damage	-0.47	0.16	8.83	0.003	0.01	0.18	0.00	0.9619	-0.47	0.15	9.97	0.0016
Driver with passengers	-0.39	0.10	14.40	0.0001	0.00	0.11	0.00	0.998	-0.39	0.07	29.31	<.0001
Driver safety belt used	0.53	0.14	14.06	0.0002	0.57	0.16	12.97	0.0003	-0.05	0.13	0.14	0.7128
Ejected	-1.38	0.50	7.64	0.0057	-1.13	0.59	3.69	0.0548	-0.25	0.56	0.19	0.6591
Not injured	0.34	0.12	8.09	0.0044	-0.08	0.13	0.36	0.5506	0.42	0.10	18.55	<.0001
Speed limit<35 mph	-0.95	0.10	85.29	<.0001	0.39	0.11	12.76	0.0004	-1.33	0.07	399.71	<.0001
Speed limit>60 mph	0.82	0.21	14.94	0.0001	-0.01	0.30	0.00	0.9685	0.83	0.27	9.68	0.0019
Concrete road surface type	-0.36	0.10	12.51	0.0004	-0.50	0.11	20.04	<.0001	0.14	0.07	3.89	0.0485
Gravel/brick road surface type	-3.07	0.26	143.29	<.0001	-1.54	0.23	45.99	<.0001	-1.53	0.24	39.26	<.0001
Poor surface condition	-0.38	0.13	8.90	0.0029	-0.33	0.14	5.62	0.0178	-0.05	0.10	0.25	0.6139
Curved road	-1.83	0.15	153.70	<.0001	-2.38	0.19	156.35	<.0001	0.56	0.17	10.83	0.001
Work zone related	0.49	0.25	3.78	0.0519	-0.29	0.31	0.90	0.3423	0.79	0.21	13.77	0.0002
Multi-lanes road	0.72	0.20	12.46	0.0004	0.51	0.22	5.20	0.0226	0.20	0.18	1.34	0.2475
9.00-13.00-Noon	0.32	0.15	4.59	0.0322	0.45	0.16	7.36	0.0067	-0.13	0.11	1.39	0.2379
13.00-17.00-Afternoon	0.91	0.14	40.83	<.0001	0.82	0.16	27.25	<.0001	0.09	0.10	0.82	0.365
17.00-21.00-Evening	0.51	0.14	12.53	0.0004	0.38	0.16	5.55	0.0185	0.13	0.11	1.48	0.2238

Table 3.19 Likelihood of Different Types of Crashes Based on Young-Adult Driver Distraction for Other Factors (continued)

Variable	Rear-End Crash Versus Single-Vehicle Crash				Angular Crash Versus Single-Vehicle Crash				Rear-End Crash Versus Angular Crash			
	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq	Estimate	SD Error	ChiSq	Pr > ChiSq
21.00-5.00-Night	-1.40	0.14	93.45	<.0001	-0.92	0.17	29.76	<.0001	-0.48	0.14	11.87	0.0006
Weekend	-0.93	0.18	25.98	<.0001	-0.33	0.22	2.28	0.1314	-0.60	0.17	12.87	0.0003
At intersection	0.98	0.10	91.98	<.0001	1.85	0.11	266.12	<.0001	-0.87	0.07	136.82	<.0001
Off roadway crash	-5.39	0.23	559.75	<.0001	-3.49	0.23	232.32	<.0001	-1.90	0.30	39.39	<.0001
Rural roads	-0.76	0.12	39.85	<.0001	0.15	0.13	1.20	0.2724	-0.91	0.10	81.04	<.0001
Animal factors	0.57	0.29	3.85	0.0496	0.90	0.31	8.45	0.0037	-0.33	0.20	2.65	0.1032
Road factors	-0.68	0.23	9.05	0.0026	-0.64	0.26	5.94	0.0148	-0.05	0.20	0.05	0.8194
Number of observations	11,084											
AIC	10,854.97											
SC	11,571.67											
-2 Log L	10,658.97											
Likelihood Ratio	10,525.94			<.0001								
Score	10,102.58			<.0001								

Table 3.20 Odds Ratio Estimates of Occurrence of Different Types of Crashes Based on Young-Adult Driver Distraction for Other Factors

Variable	Rear-End Crash Versus Single-Vehicle Crash			Angular Crash Versus Single-Vehicle Crash			Rear-End Crash Versus Angular Crash		
	Point Estimate	95% Confidence Limits		Point Estimate	95% Confidence Limits		Point Estimate	95% Confidence Limits	
Valid licensed	1.79	1.38	2.32	1.65	1.24	2.20	n.s.; 1.08	0.88	1.33
Alcohol/drug related	0.44	0.31	0.62	0.24	0.16	0.38	1.81	1.17	2.79
Pickup-truck/camper-rv	0.73	0.57	0.93	n.s.; 0.91	0.70	1.18	0.80	0.68	0.95
Turn/changing lanes maneuver	0.22	0.17	0.28	3.78	2.94	4.86	0.06	0.05	0.07
Avoiding maneuver	0.34	0.22	0.54	n.s.; 0.75	0.44	1.27	0.45	0.31	0.68
Stopped/Parking/backing maneuver	2.19	1.41	3.40	n.s.; 1.11	0.67	1.82	1.98	1.49	2.64
No damage	2.61	1.19	5.70	n.s.; 0.54	0.21	1.36	4.87	2.57	9.20
Minor damage	5.60	4.22	7.44	2.68	1.98	3.63	2.09	1.77	2.47
Functional damage	2.97	2.38	3.70	2.25	1.78	2.86	1.32	1.14	1.53
Destroyed damage	0.63	0.46	0.85	n.s.; 1.01	0.71	1.43	0.62	0.46	0.84
Driver with passengers	0.67	0.55	0.83	n.s.; 1.00	0.80	1.25	0.67	0.59	0.78
Driver safety belt used	1.69	1.29	2.23	1.78	1.30	2.43	n.s.; 0.95	0.74	1.22
Ejected	0.25	0.10	0.67	n.s.; 0.32	0.10	1.02	n.s.; 0.78	0.26	2.35
Not injured	1.41	1.11	1.78	n.s.; 0.92	0.71	1.20	1.52	1.26	1.84
Speed limit<35 mph	0.39	0.32	0.48	1.47	1.19	1.82	0.26	0.23	0.30
Speed limit>60 mph	2.26	1.50	3.42	n.s.; 0.99	0.55	1.79	2.29	1.36	3.85
Concrete road surface type	0.70	0.57	0.85	0.61	0.49	0.75	1.16	1.00	1.33
Gravel/brick road surface type	0.05	0.03	0.08	0.22	0.14	0.34	0.22	0.13	0.35
Poor surface condition	0.68	0.53	0.88	0.72	0.54	0.94	n.s.; 0.95	0.79	1.15
Curved road	0.16	0.12	0.22	0.09	0.06	0.13	1.74	1.25	2.43
Work zone related	n.s.; 1.64	1.00	2.69	n.s.; 0.75	0.41	1.36	2.19	1.45	3.32
Multi-lanes road	2.05	1.37	3.04	1.67	1.08	2.59	n.s.; 1.23	0.87	1.73
9.00-13.00-Noon	1.38	1.03	1.85	1.56	1.13	2.16	n.s.; 0.88	0.71	1.09
13.00-17.00-Afternoon	2.48	1.88	3.28	2.27	1.67	3.08	n.s.; 1.10	0.90	1.33
17.00-21.00-Evening	1.66	1.26	2.21	1.46	1.07	2.01	n.s.; 1.14	0.92	1.40
21.00-5.00-Night	0.25	0.19	0.33	0.40	0.29	0.56	0.62	0.47	0.81
Weekend	0.40	0.28	0.56	n.s.; 0.72	0.47	1.10	0.55	0.40	0.76
At intersection	2.66	2.18	3.25	6.36	5.09	7.94	0.42	0.36	0.49
Off roadway crash	0.01	0.00	0.01	0.03	0.02	0.05	0.15	0.08	0.27
Rural roads	0.47	0.37	0.59	n.s.; 1.16	0.89	1.51	0.40	0.33	0.49
Animal factors	1.78	1.00	3.15	2.46	1.34	4.51	n.s.; 0.72	0.49	1.07
Road factors	0.50	0.32	0.79	0.53	0.32	0.88	n.s.; 0.96	0.65	1.41

Note: n.s. indicates no significance found at $\alpha = 0.05$ level.

Distracted young-adult drivers' model indicated that alcohol/drug related, driving on concrete roads surface, and driving on curved roads have similar effects on young-adult drivers'

collision types. These three variables contributed to decrease the odds of occurrence of rear-end collisions or angular collisions when compared to single-vehicle crashes (OR=0.44 and 0.24 for alcohol/drug related; 0.70 and 0.61 for concrete roads surface; 0.16 and 0.09 for curved roads). However, they contributed to increase the odds of occurrence of rear-end collisions when compared to angular collisions (OR=1.81; 1.16; 1.74, respectively). Driving on gravel/brick roads surface, night driving, and involved in off road crash have a similar trend in probability of rear-end collisions and angular collisions when compared to single-vehicle crashes. However, they have a reverse trend in rear-end collisions when compared to angular collisions.

The model results showed that when young-adult drivers made turns or changed lanes they were more probable to be involved in a single-vehicle crash or an angular crash when compared to a rear-end crash. Additionally, they were more probable to be involved in an angular crash when compared to a single-vehicle crash. Similar trend in probability of a specific collision was also observed when young-adult drove on roads with speed limit less than 35 mph. At an intersection, young-adult drivers were more likely to be involved in both a rear-end crash (OR = 2.66) or an angular crash (OR = 6.36) when compared to a single-vehicle crash. However, they were less likely to be involved in a rear-end crash (OR = 0.42) when compared to an angular crash. The model results showed that young-adult drivers who involved in minor or functional vehicle damage crash were more likely to be involved in a rear-end crash or an angular crash when compared to a single-vehicle crash (OR=5.60 and 2.68 for minor vehicle damage crash; 2.97 and 2.25 for functional vehicle damage crash). Additionally, they were more likely to be involved in a rear-end crash when compared to an angular crash (OR=2.09; 1.32, respectively).

Distracted young-adult drivers' model showed that when young-adult drivers stopped/ parked/backed maneuver, involved in no damage vehicle crash, suffered not injured due to crash, or drove on roads with speed limit more 60 mph, they were more likely to be involved in rear-end crashes when compared to both single-vehicle crashes or angular crashes (OR=2.19 and 1.98 for stopping/parking/backing maneuver; 2.61 and 4.87 for no damage vehicle crash;1.41 and 1.52 for not injured; 2.26 and 2.29 for speed limit more 60 mph). However, when young-adult drivers drove pickup truck, avoided maneuver, drove with passengers, drove on weekend, or drove on rural roads, they were more likely to be involved in single-vehicle crashes or angular crashes when compared to rear-end crashes (OR=1.36 and 1.25 for drove pickup truck; 2.94 and 2.22 for avoided maneuver; 1.49 and 1.49 for drove with teenage passengers; 2.5 and 1.81 for drove on the weekend; 2.12 and 2.5 for drove on rural roads). Similar trend in probability of a particular collision was also detected when young-adult drivers involved in destroyed vehicle damage crash.

The model findings showed that young-adult drivers who held a valid license, safety belt used, drove on multi lanes roads, noon driving, afternoon driving, or evening driving were more likely to be involved in rear-end collisions or angular collisions when compared to single-vehicle crashes (OR= 1.79 and 1.65 for held valid license; 1.69 and 1.78 for safety belt used; 2.05 and 1.67 for multi lanes roads; 1.38 and 1.56 for noon driving; 2.48 and 2.27 for afternoon driving; 1.66 and 1.46 for evening driving). Likewise, when animal factors involved in young-adult drivers' crashes, the odds of a rear-end crash or an angular crash was almost two times greater than a single-vehicle crash. However, reverse trend in probability of a specific collision was observed when young-adult drivers drove on poor surface condition roads. Furthermore, when road factors involved in young-adult drivers' crashes, the odds of a single-vehicle crash was

almost two times greater than a rear-end crash or an angular crash. Moreover, the model results showed that young-adult drivers who ejected due to the crash were four times more likely to be involved in a single-vehicle crash than a rear-end crash. However, when young-adult drivers involved in crashes work zone related, they were more likely to be involved in a rear-end crash than an angular crash (OR= 2.19).

Young-adult drivers' model with 2-way interaction and young-adult drivers' model without 2-way interaction were compared using the AIC, SC, and -2 Log L values. In this study, it clear to show that the young-adult drivers' model with 2-way interaction is the best model when compared to the young-adult drivers' model without 2-way interaction model because this model has the lowest value of AIC, SC, and -2 Log L (13,056.73; 13,750.70; 12,872.73, respectively) as given in Table 3.21. Based on this statistic evidence, it can be concluded that, in general, the interaction terms statistically improves the overall fit of the young-adult driver's model.

Table 3.21 Comparison of Statistically Models Fit of Young-Adult Drivers' Crash Type Model with and without 2-Way Interaction

Criterion	Young-adult Drivers' Crash Type Model with 2-Way Interaction		Young-adult Drivers' Crash Type Model without 2-Way Interaction	
	Intercept Only	Intercept and Covariates	Intercept Only	Intercept and Covariates
AIC	21,188.91	10,854.97	21,188.91	10,915.70
SC	21,203.54	11,571.67	21,203.54	11,676.28
-2 Log L	21,184.91	10,658.97	21,184.91	10,707.70

3.3 Effects of Distractions on Injury Severity Sustained by Young Drivers and their Passengers Involved in Crashes

This section includes the data description, methodologies, and results of the effects of distractions on injury severity sustained by teenage and young-adult drivers and their passengers involved in crashes.

3.3.1 Data Description

The data used in this study were different from that used in the previous section which focused on crash type, because this analysis included the drivers and their passengers' information. The models in this study were built using an observation for each teenage and young-adult distracted drivers and their passengers involved in crashes. Thus, the characteristics each teenage and young-adult distracted drivers were used as covariates for their passengers as well as other factors (e.g., driver, environmental, and crash characteristics).

3.3.2 Methodologies

3.3.2.1 Introduction

The main objective of this study was to predict the likelihood of a severe injury for teenage and young-adult distracted drivers and their passengers involved in crashes. In addition, this study evaluated the interactions between teenage and young-adult drivers' distraction types and other factors (e.g., driver, passengers, environmental, and crash characteristics). The dependent variable was the injury severity of teenage and young-adult distracted drivers and their passengers. Due to the dependent variable has multi-level ordered categories and as previous crash injury severity studies [14, 19, 20, and 22], the ordered logistic regression was selected as

the model estimation. The ordered logistic regression model is used for modeling ordered categories where dependent variable has an inherent order [55].

3.3.2.2 Ordered Logistic Regression

An ordered logistic regression model is a simple extension of a binary logistic model, however an ordered logistic regression model can treat more than two ordered categories of the dependent variable [55]. Like the multinomial logit modeling, an ordered logistic regression model also uses the method of maximum likelihood estimation to assess the probability that the dependent variable will be in one category as compared to another category. This modeling technique was used to identify the odds of more severe injuries for teenage and young-adult distracted drivers and their passengers. In particular, the odds of a severe injury for teenage and young-adult distracted drivers and their passengers was defined as the likelihood of a more severe injury divided by the likelihood of a less severe injury. One unit increase in value of odds indicates one unit increase in the likelihood of a more severe injury as going up on the ordinal scale.

There are four levels of injury severity which are classified on an ordinal scale from no injuries, possible injuries, injuries, and fatal/severe injuries. These four categories can be interpreted in three logit equations. Thus, the logit equations are represented the log-odds of severe injuries for: “fatal/severe injuries” versus “injuries”, “possible injuries”, and “no injuries” (eqn. 3.18); “fatal/severe injuries” and “injuries” versus “possible injuries” and “no injuries” (eqn. 3.19); and “fatal/severe injuries”, “injuries”, and “possible injuries” versus “no injuries” (eqn. 3.20).

$$\log\left(\frac{p_1}{1-p_1}\right) = \beta_1 x_i \quad (3.18)$$

$$\log\left(\frac{p_1+p_2}{1-p_1-p_2}\right) = \beta_2 x_i \quad (3.19)$$

$$\log\left(\frac{p_1+p_2+p_3}{1-p_1-p_2-p_3}\right) = \beta_3 x_i \quad (3.20)$$

Where,

p_1 =probability of a fatal/severe injury for observation i,

p_2 = probability of an injury for observation i,

p_3 = probability of a possible injury for observation i,

x_i = explanatory variables for observation i , and

$\beta' s$ = parameter estimates.

3.3.3 Results of Injury Severity Models

3.3.3.1 Collinearity Analysis for Injury Severity Model of Teenage Drivers and their Passengers

Before running ordered logistic regression model, a Correlation Matrix was developed to detect highly correlated observed variables which is shown in Appendix A.3. Hence, sixteen models were ran, one of the correlated explanatory variables that causes to increase AIC and SC values was removed from the model one at a time while keeping everything else constant.

There were 8 highly correlated pairs in teenage drivers and their passengers' injury severity data set which included: concrete roads and black top roads, wet/debris roads and

adverse weather conditions, speed limit (less than 35 mph) and speed limit (35-60 mph), female occupants and male driver, on roadway crash and at intersection crash, straight-following maneuver and turn or changing lanes maneuver, 21.00-5.00-night and dark, and single-vehicle crash and off-roadway crash. among these highly correlated pairs, variables of concrete roads, adverse weather conditions, speed limit (35-60 mph), male driver, at intersection crashes, turn or changing lanes maneuver, dark, and off-roadway crash, were included in the final model.

Table 3.22 Collinearity Analysis for Injury Severity Model of Teenage Drivers and their Passengers

Variable 1	Variable 2	Correlation Coefficient	Variables Considered to be Included in the Model
Concrete roads	Black top roads	-0.833	Concrete roads
Wet/debris roads	Adverse weather conditions	0.775	Adverse weather conditions
Speed limit (Less than 35 mph)	Speed limit (35-60 mph)	-0.770	Speed limit (35-60 mph)
Female occupants	Male driver	-0.737	Male driver
On roadway crashes	At intersection crashes	-0.719	At intersection crashes
Straight-following maneuver	Turn or changing lanes maneuver	-0.709	Turn or changing lanes maneuver
21.00-5.00-Night	Dark	0.667	Dark
Single-vehicle crash	Off-roadway crash	0.639	Off-roadway crash

3.3.3.2 Ordered Logistic Regression Model Results for Teenage Driver and their Passengers

An ordered logit model procedure in SAS software (version 9.4) was used to determine how different distraction types and other factors affect on crash injury severities among teenage drivers (15–20 year old) and their passengers. There were 24,084 observations of teenage distracted drivers and their passengers that included in the ordered logit model. In this model, injury severity was the dependent variable, which consisted of four levels of injury severity (no injuries, possible injuries, injuries, and fatal/severe injuries). All variables that depicted in Tables

3.3 through 3.9 and their interactions with distraction types were included in the ordered logit model as predictor variables. All of these predictor variables were coded as dummy variables. However, predictor variables that have no significant differences at a confidence level of 95% were removed from the final model by using stepwise selection. The predictor variables of the final model are presented in Tables 3.23 and 3.24.

Each predictor variable has confidence estimate, standard error, Chi Square statistic, odds ratio, confidence interval and p-value as shown in Tables 3.23 and 3.24. In this model, the overall model fit statistical presented a Likelihood Ratio of 5,133, whose p-value is < 0.0001, meaning that injury severity model of teenage distracted drivers and their passengers fits the data well.

Table 3.23 Maximum Likelihood of a Severe Injury in a Distraction-Affected Crash Based on Teenage Drivers Distraction and their Passengers for Distraction Types and their Interaction with Other Factors

Variable	Estimate	SD Error	ChiSq	Odds Ratio	95% Confidence Limits		Pr > ChiSq
Intercept (Fatal/severe injury)	-4.89	0.13	1476.87				<.0001
Intercept (Injury)	-2.67	0.11	568.03				<.0001
Intercept (Possible injury)	-1.74	0.11	249.51				<.0001
Cell phone related distraction							
Teenage driver distracted by cell phone*	0.72	0.15	21.81	2.05	1.52	2.77	<.0001
Cell phone *Passenger**	0.47	0.22	4.54	1.60	1.04	2.46	0.0331
Cell phone *Male driver*	-0.93	0.22	18.51	0.39	0.26	0.60	<.0001
Cell phone *Functional damage	-2.17	0.40	28.62	0.12	0.05	0.25	<.0001
Cell phone *Alcohol/drug related	0.92	0.29	10.11	2.52	1.42	4.44	0.0015
Other electronic devices related distraction							
Teenage driver distracted by other electronic devices*	0.35	0.18	3.87	1.42	1.00	2.02	0.0492
Other electronic devices *Functional damage	-1.03	0.37	7.71	0.36	0.17	0.74	0.0055
Other electronic devices *Vehicle age (11-15 years)	-0.64	0.31	4.15	0.53	0.29	0.98	0.0416
In/on-vehicle related distraction							
Teenage driver distracted In/on-vehicle*	0.28	0.09	8.89	1.32	1.10	1.58	0.0029
In/on-vehicle distraction*Passenger**	0.26	0.10	7.47	1.30	1.08	1.58	0.0063
In/on-vehicle distraction*Male driver*	-0.56	0.13	17.81	0.57	0.44	0.74	<.0001
External distraction							
External distraction teenage driver*	-0.35	0.17	4.26	0.70	0.50	0.98	0.039
External distraction*Alcohol/drug related	1.82	0.58	9.86	6.15	1.98	19.09	0.0017
External distraction*Destroyed damage	1.39	0.37	14.41	4.03	1.96	8.29	0.0001
Inattention							
Inattention *Passenger**	-0.32	0.06	26.73	0.72	0.64	0.82	<.0001
Inattention *Destroyed damage	1.57	0.06	624.11	4.83	4.26	5.46	<.0001
Inattention *Male driver*	-0.61	0.06	115.36	0.55	0.49	0.61	<.0001
Inattention *Week end	-0.41	0.08	24.33	0.66	0.56	0.78	<.0001
Inattention *Driver safety belt not used*	0.45	0.13	12.46	1.57	1.22	2.02	0.0004

Base: * Severe injury for only drivers, and
Base: ** Severe injury for only passengers.

As mentioned previously, the major purpose of this model was to predict the likelihood of a severe injury for teenage distracted drivers and their passengers involved in crashes. Consequently, the results of the distracted teenage drivers' model are interpreted in terms of having a more severe injury. In most teenage driver distraction categories in this model, teenage drivers were more likely to be injured. In particular, teenage drivers have a significantly

increased likelihood of being severely injured if they were distracted by a cell phone (OR= 2.05), by other electronic devices (OR= 1.42), or inside the vehicle (OR= 1.32) than if they were distracted by external distractions (OR= 0.70). However, this model results showed that no significant effect on crash injury severity was observed for inattentive teenage drivers. Passengers of distracted teenage drivers were also included in this model as predictor variable. Accordingly, passengers had a higher likelihood of being severely injured when their distracted teenage drivers were distracted by a cell phone or inside the vehicle than when their teenage drivers were inattentive. However, male teenage drivers were less probable to be injured than female teenage drivers when they were distracted by a cell phone, inside the vehicle, or were inattentive.

The model results showed that when teenage drivers involved in destroyed vehicle damage crash while they were distracted by external distractions or were inattentive, the occupants (teenage drivers and their passengers) had a significantly increased likelihood of sustaining a severe injury (OR=4.03 and 4.83, respectively) than when teenage drivers involved in functional vehicle damage crash while they were distracted by a cell phone or by other electronic devices (OR=0.12 and 0.36, respectively). In addition, the model results showed that teenage drivers who consumed alcohol while they were distracted by a cell phone or external distractions, they and their passengers had a higher probability of being severely injured (OR=2.52 for cell phone distractions and OR=6.15 for external distractions). If teenage drivers drove vehicle aged between 11 to 15 years old and distracted by other electronic devices, the occupants were less likely to be injured. Similar trend in probability of injury severity was observed when teenage drivers were inattentive on the weekend. However, the model also

showed that inattentive teenage drivers who did not use seat belt at the time of the crash were more likely to be injured.

Table 3.24 Maximum Likelihood of a Severe Injury in a Distraction-Affected Crash Based on Teenage Drivers Distraction and their Passengers for Other Factors

Variable	Estimate	SD Error	ChiSq	Odds Ratio	95% Confidence Limits		Pr > ChiSq
Valid licensed	-0.13	0.06	4.76	0.88	0.78	0.99	0.0291
Vehicle age (Year 5 or newer)	-0.44	0.13	11.29	0.64	0.50	0.83	0.0008
Vehicle age (Year 16 or older)	0.09	0.04	5.02	1.10	1.01	1.19	0.0251
No damage	-1.61	0.28	33.29	0.20	0.12	0.35	<.0001
Minor damage	-1.70	0.09	326.05	0.18	0.15	0.22	<.0001
Van	-0.28	0.12	5.59	0.75	0.60	0.95	0.0181
Speed limit (more than 60 mph)	0.76	0.05	208.11	2.13	1.92	2.36	<.0001
Adverse weather conditions	-0.14	0.07	3.87	0.87	0.76	1.00	0.049
Week end	0.34	0.07	27.21	1.41	1.24	1.61	<.0001
Head on	0.42	0.12	12.00	1.53	1.20	1.94	0.0005
Rear end	-0.72	0.06	150.29	0.49	0.44	0.55	<.0001
Angle	-0.29	0.07	19.16	0.75	0.66	0.85	<.0001
Sideswipe: same direction	-1.63	0.17	91.41	0.20	0.14	0.27	<.0001
Backed into	-2.09	0.50	17.30	0.12	0.05	0.33	<.0001
Off roadway crash	0.16	0.06	7.76	1.17	1.05	1.31	0.0053
Rural roads	0.44	0.04	95.48	1.55	1.42	1.69	<.0001
No seatbelt use	1.21	0.08	233.43	3.36	2.88	3.93	<.0001
Occupants ejection	2.55	0.16	250.42	12.75	9.30	17.47	<.0001
Front-seat occupants	0.32	0.08	16.78	1.38	1.18	1.61	<.0001
Number of observations	24,084						
AIC	22,201.06						
SC	22,532.72						
-2 Log L	22,119.06						
Likelihood Ratio	5,133.64						<.0001
Score	5,515.38						<.0001

Distracted teenage drivers' model showed that in general valid licensed drivers, involving a crash with no vehicle damage, involving in minor vehicle damage crash, driving van vehicles, and adverse weather conditions decreased the odds of severe injuries for the occupants. In contrast, driving on roads with high speed limits, driving on weekend, and off roadway crash

increased the odds of severe injuries for the occupants. Furthermore, teenage drivers and their passengers were more likely to be injured on rural roads than on urban roads. As expected, new vehicles (OR = 0.64) resulted in decreased odds of injury severity for the occupants while old vehicles (OR = 1.10) resulted in increased the odds of being injury. In terms of crash types, the model showed that teenage drivers and their passengers were more likely to be injured when they involved in head on crash while they were less likely to be injured when they involved in rear end, angle, sideswipe same direction, and backed into crashes.

The model results showed that teenage drivers and their front-seat occupants were more likely to be injured (OR= 1.38). In addition, the model results indicated that seat belt not usage at the time of the crash increased injury severity for the occupants. Likewise, the results showed that when teenage drivers and their passengers ejected due to crash, they had substantially higher probability of being severely injured (OR = 12.75).

Injury severity model of teenage drivers' distraction and their passengers with 2-way interaction and injury severity model of teenage drivers' distraction and their passengers without 2-way interaction were compared using the AIC, SC, and -2 Log L values. In this study, it clear to show that the model with 2-way interaction is the best model when compared to the model without 2-way interaction because this model has the lowest value of AIC, SC, and -2 Log L (22,201.05; 22,532.71; 22,119.05, respectively) as given in Table 3.25. Based on this statistic evidence, it can be concluded that, in general, the interaction terms statistically improves the overall fit of the injury severity model of teenage drivers' distraction and their passengers.

Table 3.25 Comparison of Statistically Models Fit of Injury Severity Model of Teenage Drivers' Distraction and their Passengers with and without 2-Way Interaction

Criterion	Injury Severity Model of Teenage Drivers' Distraction and their Passengers with 2-Way Interaction		Injury Severity Model of Teenage Drivers' Distraction and their Passengers without 2-Way Interaction	
	Intercept Only	Intercept and Covariates	Intercept Only	Intercept and Covariates
AIC	27,258.70	22,201.05	27,258.70	22,998.95
SC	27,282.96	22,532.71	27,282.96	23,209.27
-2 Log L	27,252.70	22,119.05	27,252.70	22,946.95

3.3.3.3 Collinearity Analysis for Injury Severity Model of Young-Adult and their Passengers

The highly correlated pairs and variables considered to be included in the final model are shown in Table 3.26. Also, The Correlation Matrix is presented in detail in Appendix A.4.

Table 3.26 Collinearity Analysis for Injury Severity Model of Young-Adult and their Passengers

Variable 1	Variable 2	Correlation Coefficient	Variables Considered to be Included in the Model
Concrete roads	Black top roads	-0.893	Concrete roads
Female occupants	Male driver	-0.766	Female occupants
Wet/debris roads	Adverse weather conditions	0.762	Adverse weather conditions
On roadway crash	At intersection crash	-0.739	At intersection crash
Speed limit (Less than 35 mph)	Speed limit (35-60 mph)	-0.716	Speed limit (Less than 35 mph)
21.00-5.00-Night	Dark	0.692	Dark
Straight-following maneuver	Turn or changing lanes maneuver	-0.673	Straight-following maneuver
Single-vehicle crash	Off-roadway crash	0.635	Off-roadway crash

3.3.3.4 Ordered Logistic Regression Model Results for Young-Adult Driver and their Passengers

An ordered logit model procedure in SAS software (version 9.4) was used to determine how different distraction types and other factors affect on crash injury severities among young-adult drivers (21–26 year old) and their passengers. There were 18,223 observations of young-adult distracted drivers and their passengers that included in the ordered logit model. In this model, injury severity was the dependent variable, which consisted of four levels of injury severity (no injuries, possible injuries, injuries, and fatal/severe injuries). All variables that depicted in Tables 3.3 through 3.9 and their interactions with distraction types were included in the ordered logit model as predictor variables. All of these predictor variables were coded as dummy variables. However, predictor variables that have no significant differences at a confidence level of 95% were removed from the final model by using stepwise selection. The predictor variables of the final model are presented in Tables 3.27 and 3.28. Each predictor variable has confidence estimate, standard error, Chi Square statistic, odds ratio, confidence interval, and p-value. In this model, the overall model fit statistical presented a Likelihood Ratio of 4,703, whose p-value is < 0.0001. This means that injury severity model for young-adult distracted drivers and their passengers fits the data well.

Table 3.27 Maximum Likelihood of a Severe Injury in a Distraction-Affected Crash Based on Young-Adult Drivers Distraction and their Passengers for Distraction Types and their Interaction with Other Factors

Variable	Estimate	SD Error	ChiSq	Odds Ratio	95% Confidence Limits		Pr > ChiSq
Intercept (Fatal/severe injury)	-6.01	0.12	2401.59				<.0001
Intercept (Injury)	-3.82	0.10	1360.88				<.0001
Intercept (Possible injury)	-2.90	0.10	834.99				<.0001
Cell phone related distraction							
Young-adult driver distracted by cell phone*	0.29	0.12	5.61	1.34	1.05	1.71	0.0179
Cell phone *Work zone related	1.01	0.50	4.09	2.75	1.03	7.31	0.0431
Cell phone *Curved road	0.50	0.25	4.10	1.65	1.02	2.68	0.0429
In/on-vehicle related distraction							
Young-adult driver distracted In/on-vehicle*	-1.38	0.26	27.57	0.25	0.15	0.42	<.0001
In/on-vehicle distraction*Alcohol/drug related	0.84	0.24	12.24	2.32	1.45	3.71	0.0005
In/on-vehicle distraction*Work zone related	0.95	0.39	5.80	2.58	1.19	5.57	0.016
In/on-vehicle distraction*Passenger**	-1.16	0.19	38.85	0.31	0.22	0.45	<.0001
In/on-vehicle distraction*Driver seatbelt not used*	0.77	0.26	8.74	2.15	1.30	3.57	0.0031
In/on-vehicle distraction*Vehicle age (Year 16 or older)	0.66	0.14	22.44	1.93	1.47	2.53	<.0001
In/on-vehicle distraction*Vehicle age (Year 5 or newer)	0.63	0.25	6.34	1.89	1.15	3.09	0.0118
In/on-vehicle distraction*Front-seat occupants	1.10	0.24	21.39	3.00	1.88	4.78	<.0001
External distraction							
External distraction young-adult driver*	-1.49	0.48	9.59	0.23	0.09	0.58	0.002
External distraction*Vehicle age (Year 16 or older)	1.57	0.52	9.07	4.80	1.73	13.33	0.0026
External distraction*Vehicle age (11-15 years)	1.23	0.54	5.06	3.41	1.17	9.91	0.0244
External distraction*Driver seatbelt not used*	2.05	0.60	11.56	7.74	2.38	25.17	0.0007
External distraction*Passenger**	-1.88	0.58	10.70	0.15	0.05	0.47	0.0011
Inattention							
Inattentive young-adult driver*	-0.23	0.08	7.52	0.80	0.68	0.94	0.0061
Inattention *Front-seat occupants	0.18	0.09	3.91	1.20	1.00	1.43	0.0479
Inattention *Driver seatbelt not used*	1.25	0.13	87.04	3.47	2.67	4.51	<.0001

Base: * Severe injury for only drivers, and
Base: ** Severe injury for only passengers

As mentioned previously, the major purpose of this model was to predict the probability of a severe injury for young-adult distracted drivers and their passengers involved in crashes. Consequently, the results of the distracted young-adult drivers' model are interpreted in terms of having a more severe injury. In most young-adult driver distraction categories in this model, young-adult drivers were less likely to be injured. In particular, young-adult drivers had a decreased probability of being severely injured when they were distracted inside the vehicle (OR= 0.25), by external distractions (OR= 0.23), or were inattentive (OR= 0.80). In contrast, young-adult drivers had an increased probability of being severely injured when they were distracted by a cell phone (OR= 1.34). However, this model results showed that no significant effect on crash injury severity was observed for young-adult drivers distracted by other electronic devices. Passengers of distracted young-adult drivers were also included in this model as predictor variable. Accordingly, passengers were less likely to be injured when their distracted young-adult drivers were distracted inside the vehicle or by external distractions. However, young-adult drivers who did not use seat belt at the time of the crash had a significantly increased probability of being severely injured when they were distracted inside the vehicle (OR= 2.15), by external distractions (OR= 7.74), or were inattentive (OR=3.47).

The model results showed that when young-adult drivers involved in work zone crash while they were distracted by a cell phone or inside the vehicle, the occupants (young-adult drivers and their passengers) had a significantly increased probability of sustaining a severe injury (OR=2.75 and 2.58, respectively). Likewise, young-adult drivers that were distracted on curved roads by cell phones, they and their passengers were more likely to be injured (OR = 1.65). In addition, this model results indicated that young-adult drivers who have consumed alcohol while they were distracted inside the vehicle, they and their passengers had a higher

probability of being severely injured (OR=2.32). If young-adult drivers drove old vehicles and distracted inside the vehicle or by external distractions, they and their passengers were more likely to be injured (OR=1.93 and 4.80, respectively). Similar trend in probability of injury severity was also observed when young-adult drivers drove new vehicles and distracted inside the vehicle as well as when they drove vehicle age between 11 to 15 years old and distracted by external distractions. In addition, the model results showed that young-adult drivers and their front-seat passengers had a significantly increased probability of being severely injured when the drivers were distracted inside the vehicle or were inattentive.

Table 3.28 Maximum Likelihood of a Severe Injury in a Distraction-Affected Crash Based on Young-Adult Drivers Distraction and their Passengers for Other Factors

Variable	Estimate	SD Error	ChiSq	Odds Ratio	95% Confidence Limits		Pr > ChiSq
Alcohol/drug related	0.34	0.08	17.00	1.40	1.19	1.65	<.0001
No damage	-1.30	0.47	7.63	0.27	0.11	0.69	0.0057
Minor damage	-0.70	0.12	32.96	0.50	0.39	0.63	<.0001
Disabling damage	1.54	0.07	456.00	4.67	4.05	5.38	<.0001
Destroyed damage	2.88	0.09	1144.18	17.84	15.10	21.08	<.0001
Speed limit (Less than 35 mph)	-0.29	0.06	23.53	0.75	0.66	0.84	<.0001
Speed limit (more than 60 mph)	0.36	0.06	36.40	1.44	1.28	1.62	<.0001
Adverse weather conditions	-0.20	0.08	6.24	0.82	0.70	0.96	0.0125
Head on	0.45	0.14	9.68	1.57	1.18	2.08	0.0019
Rear end	-0.43	0.06	58.92	0.65	0.58	0.72	<.0001
Sideswipe: same direction	-0.78	0.17	21.01	0.46	0.33	0.64	<.0001
Backed into	-1.91	0.72	7.04	0.15	0.04	0.61	0.008
Dark	-0.12	0.05	5.29	0.89	0.80	0.98	0.0215
No seatbelt use	0.55	0.08	43.09	1.74	1.47	2.05	<.0001
Rural roads	0.19	0.06	11.31	1.21	1.08	1.35	0.0008
Concrete roads	-0.14	0.06	6.56	0.87	0.78	0.97	0.0104
Female occupants	0.32	0.05	44.76	1.38	1.25	1.51	<.0001
Occupants ejection	2.47	0.17	205.37	11.82	8.43	16.57	<.0001
Number of observations	18,223						
AIC	16,243.18						
SC	16,555.60						
-2 Log L	16,163.18						
Likelihood Ratio	4,703.57						<.0001
Score	5,029.13						<.0001

Injury severity model of young-adult drivers and their passengers indicated that alcohol/drug related and driving on rural roads increased the odds of severe injuries for the occupants (young-adult drivers and their passengers). Whereas, adverse weather conditions, dark roadways, and driving on concrete roads surface decreased the odds of severe injuries for the occupants. In addition, the model results showed that young-adult drivers and their passengers who involved in no damage vehicle crash or minor vehicle damage crash were less likely to be injured (OR=0.27 and 0.50, respectively). In contrast, they had a significantly increased

probability of being severely injured when they involved in disabling or destroyed vehicle damage crash (OR=4.67 and 17.84, respectively). As expected, driving on roads with low speed limit (less than 35 mph) resulted in decreased odds of injury severity for the occupants (OR = 0.75) while driving on roads with high speed limit (more than 60 mph) resulted in increased odds of injury severity (OR = 1.44). In terms of crash types, the model showed that the occupants were more likely to be injured when they involved in head on crash while they were less likely to be injured when they involved in rear end, sideswipe same direction, and backed into crashes.

The model results indicated that seat belt not usage at the time of the crash increased injury severity for the occupants. Likewise, when young-adult drivers and their passengers ejected due to crash, they had substantially higher probability of being severely injured (OR = 11.82). Also, the model results showed that female occupants were more likely to be injured (OR=1.38) than male occupants.

Also, in this study, it clear to show that the injury severity model of young-adult drivers' distraction and their passengers with 2-way interaction is the best model when compared to the injury severity model of young-adult drivers' distraction and their passengers without 2-way interaction because this model has the lowest value of AIC, SC, and -2 Log L (16,243.18; 16,555.59; 16,163.18, respectively) as given in Table 3.29. Based on this statistic evidence, it can be concluded that, in general, the interaction terms statistically improves the overall fit of the injury severity model of young-adult drivers' distraction and their passengers.

Table 3.29 Comparison of Statistically Models Fit of Injury Severity Model of Young-Adult Drivers' Distraction and their Passengers with and without 2-Way Interaction

Criterion	Injury Severity Model of Young-adult Drivers' Distraction and their Passengers with 2-Way Interaction		Injury Severity Model of Young-adult Drivers' Distraction and their Passengers without 2-Way Interaction	
	Intercept Only	Intercept and Covariates	Intercept Only	Intercept and Covariates
AIC	20,872.74	16,243.18	20,872.74	16,429.01
SC	20,896.17	16,555.59	20,896.17	16,624.27
-2 Log L	20,866.74	16,163.18	20,866.74	16,379.01

3.4 The Effectiveness of Hand-Held Cell Phone Bans in Reducing Young Drivers' Crashes Involving Cell Phone Use Analysis

As discussed in chapter 2, Manhattan, Kansas and Junction City, Kansas have enacted restrictions on hand-held cell phone use while driving. These two cities ban hand-held cell phone use for drivers of all ages as primary enforcement. Additionally, the Kansas Senate Transportation Committee recently opened public hearings on a state-wide ban on hand-held cell phone use while driving which include SB99-prohibiting the operation of a motor vehicle while using wireless communication device and SB144-prohibiting the use of a wireless communication device in a school zone or a road construction zone [60]. One of the most important questions that has been raised in that meeting was whether hand-held cell phone use bans helped to reduce cell phone-related crashes in Manhattan and Junction City. It is noteworthy to mention that the City of Manhattan prohibited the hand-held cell phone use within city limits on July 1, 2010 [61], while Junction City has only prohibited hand-held cell phone use since September 15th, 2014 [62]. Therefore, Junction City cannot be used to draw clear conclusions about the effectiveness of such law in reducing young drivers' crashes involving cell phone use.

An investigation was conducted in Manhattan, Kansas to evaluate young drivers' crashes involving cell phone use before and after implementing hand-held cell phone law restrictions. Three years of crash data before (pre-law) and after (post-law) implementing the hand-held cell phone law restrictions in this city were used it to accomplish this comparison. The pre-law time period runs from 2007 to 2009, and the post-law time period runs from 2011 to 2013. The measurement used in this analysis is the average rates over the three year pre-law and post-law periods of young drivers' crashes involving cell phone use per 10,000 licensed young drivers per year in Manhattan as shown in Table 3.30. The results showed that a drop in the average rate of young drivers' crashes involving cell phone use per 10,000 licensed young drivers has been observed from the pre-law time period (average rate=3.4) to the post-law time period (average rate=2.7) in Manhattan.

Table 3.30 The Average Rate Over Three Years Periods (Pre-Law and Post-Law) of Young Drivers' Crashes Involving Cell Phone Use

Average Rate of Young Drivers' Crashes Involving Cell Phone Use per 10,000 Licensed Young Drivers per Year in Manhattan, Kansas	**Pre-Law**	**Post-Law**
	3.4	2.7

In addition, a statistical comparison was conducted for young drivers' crashes involving cell phone use in a city with a hand-held cell phone use ban (i.e., Manhattan, Kansas) and a city without a hand-held cell phone use ban (i.e., Lawrence, Kansas) in order to identify the effectiveness of hand-held cell phone use bans in reducing young drivers' crashes involving cell phone use.

In this analysis, three years of crash data from 2011 to 2013, which is after implementing hand-held cell phone law restrictions in Manhattan, were used in this investigation. The measurement used in this analysis is the average rate over three years period of young drivers'

crashes involving cell phone use per 10,000 licensed young drivers per year in both Manhattan and Lawrence as shown in Table 3.31. The analysis results presented that the average rate of young drivers' crashes involving cell phone use in a city without a hand-held cell phone use ban (i.e., Lawrence, Kansas) was almost two times greater than the average rate of young drivers' crashes involving cell phone use in a city with a hand-held cell phone use ban (i.e., Manhattan, Kansas).

Table 3.31 Comparison for Average Rate Over Three Years Period of Young Drivers' Crashes Involving Cell Phone in Cities with and without Hand-Held Cell Phone Use Bans

Average Rate of Young Drivers' Crashes Involving Cell Phone Use per 10,000 Licensed Young Drivers per Year in City with Hand-Held Cell Phone Use Bans and City without Hand-Held Cell Phone Use Bans	**Manhattan**	**Lawrence**
	2.7	6.0

3.5 Discussion

Preliminary analysis showed that more than 12% of the total young drivers' crashes were distraction-affected crashes. This analysis also revealed the interesting facts that teenage front-seat passengers were present at the time of the crash, they made up about 17% of all teenage driver distraction-affected crashes, but they only made up about 3% of all young-adult driver distraction-affected crashes. One possible explanation is that teenagers who drove with their peers as front-seat passengers were more likely to be involved in distraction-affected crashes. The crash proportions of teenage and young-adult drivers distracted by cell phones or other electronic devices were relatively small, but they had the highest probabilities of occurrence.

Results of teenage and young-adult crash type models showed that distracted driving affected the probability of rear-end, angular, and single-vehicle crashes. In this study crashes involving most distraction types for both teenage and young-adult drivers were more likely to be

rear-end or angular collisions. In particular, when teenage and young-adult drivers were distracted by their cell phones or other electronic devices, there was an elevated likelihood of rear-end or angular collisions. This differs from results of a similar study in Missouri that reported that drivers who were distracted by their cell phones or other electronic devices were more likely to be involved in single-vehicle crashes [17]. However, national and other previous study findings agree with this current study that cell phone use while driving contributes to an increased likelihood of rear-end or angular crashes [18 and 63].

In interaction terms in crash type models, cell phone distractions at intersections appeared to increase the odds of teenage and young-adult drivers being involved in angular crashes. Likewise, distractions inside the vehicle at intersections showed an increase in the odds of young-adult drivers being involved in angular crashes, a result that is in line with a previous distracted driving-related study [18]. Moreover, cell phone and in-vehicle distractions under different conditions (e.g., driving old or sport utility vehicles, driving on curved roads or on concrete road surfaces, or at intersections) appeared to increase the probability of young-adult drivers being involved in angular or single-vehicle crashes. However, when young-adult drivers were inattentive during the weekend, rear-end collisions were the most likely. For teenage drivers the model showed that cell phone distractions on roads with speed limits >60 mph increased the chances for teenage drivers to be involved in angular crashes. In addition, when these teenage drivers drove with their peers as front-seat passengers and were distracted in/on the vehicle or by other electronic devices, they were more likely to be involved in single-vehicle crashes. Another study found that drivers who drove with front-seat passengers were more likely talk to passengers while driving [22].

The results of crash type models showed that when teenage and young-adult drivers drove on rural or curved roadways or during the night time, single-vehicle crashes were the most probable crash type, a result that agrees with previous distracted-driving related studies [17, 18, and 20]. This may be because these roads lack lighting, have lower traffic flows, and have fewer warning signs, so teenage and young-adult drivers may use these signs and the directions of other vehicles as primary cues to determine the condition of the road. It is noteworthy to mention that Kansas has the second longest mileage of rural roads in the United States [64], which may contribute to the likelihood of single-vehicle crashes. Additional analysis indicated that at intersections teenage and young-adult drivers were more likely to be involved in rear-end or angular collisions. A previous study found that the main causes of rear-end or angular collisions are improper decision making and that drivers have difficulty maintaining their travel lane [18]. In other words, teenage and young-adult drivers who were distracted at intersections had a difficult time responding to critical events at the intersection because they were more focused on secondary tasks unrelated to driving, which means they may have made improper decisions that caused them to leave their travel lanes. However, this result is not consistent with another, similar study of collision estimates that reported that teenage drivers who were distracted at intersections were more probable to be involved in single-vehicle crashes [18]. Young-adult model results showed that young-adult drivers who were under the influence of alcohol or who drove with passengers or on poor surface condition roads were more likely to be associated with single-vehicle crashes. However, the teenage drivers model results indicated that angular collisions are more likely to occur when teenage drivers drove with their peers as front-seat passengers or when teenage females were driving. These findings of young-adult and teenage models agree with previous distracted driving related studies [17, 18, and 20]. According to the

results of teenage and young-adult driver models, it can be concluded that distractions could have varying effects on collision type.

Overall, there were no considerable differences between the teenage and young-adult crash type models. However, some explanatory variables showed significant effects on the crash type in one model, but did not appear significant on the other. For instance, eight explanatory variables were significant in the teenage driver model that were not significant in the young-adult driver model. In the teenage driver model these variables are vehicle age (year 5 or newer); vehicle age (6–10 years); sport utility vehicle; teenage front-seat passengers; female driver; ejected or trapped in the crash; morning driving; and other vehicle factors. On the other hand, the young-adult driver model identified seven significant explanatory variables that were not significant in the teenage model (i.e., alcohol/drug related crashes; pickup-truck/camper-rv; poor surface conditions; noon time driving; evening driving; animal factors; and road factors). Additionally, old and sport utility vehicles alone didn't significantly affect the crash types that involved the young-adult drivers. However, when young-adult drivers drove these vehicles and were distracted by their cell phones, they were more probable to be involved in single-vehicle or angular crashes.

Summaries of the results of the injury severity models indicate that distractions could have varying effects on crash-related injuries for both teenage and young-adult drivers and their passengers. In fact, teenage and young-adult drivers were more likely to be severely injured in cell phone-related crashes. These findings agree with previous distracted driving related studies [19, 65, and 66]. Male teenage drivers had a lower likelihood of sustaining severe injuries than female drivers when they were distracted by a cell phone, by a distraction inside the vehicle, or when they were inattentive. A previous distracted-driving-related study by Neyens & Boyle

(2007) also confirmed this finding [19]. Another study found that male drivers were less likely than female drivers to engage in distracting activities that occur inside the vehicle [22]. The results of the injury severity model for teenage drivers indicated that when teenage drivers were distracted by a cell phone or inside the vehicle at the time of the crash, their passengers were more likely to be injured, a result that is consistent with another similar study [19]. In addition, this model showed that distracted teenage drivers and their front-seat passengers were more probable to be injured, which is consistent with another study that also reported that, in general, distracted drivers and their front-seat passengers were more likely to be severely injured [20]. This is strong evidences to confirm that passengers of distracted teenage drivers are at risk for injuries in distraction-affected crashes. However, passengers of young-adult distracted drivers had decreased likelihood of being severely injured when their drivers were distracted inside the vehicle.

The injury severity model results for young-adult drivers revealed that when young-adult drivers were distracted by cell phones in road construction zones or on curved roads, they and their passengers were more likely to be injured. Additionally, when both teenage and young-adult drivers were distracted on rural roads, they and their passengers were also more likely to be severely injured. Other previous studies agree with these findings in that drivers who were distracted on curved roads or rural roads were more likely to be injured [20]. Interestingly when teenage and young-adult drivers were distracted while driving during adverse weather conditions, they and their passengers were less likely to be severely injured, a result that is in line with other previous distracted-driving-related studies [19 and 20].

In terms of the differences in results between the injury severity models for most distraction categories, teenage drivers were more probable to be injured, while young-adult

drivers were less probable to be injured. In addition, some explanatory variables appeared to have significant effects on crash injury severity in one model, but did not appear significant on the other. For instance, nine explanatory variables—distraction related to other electronic devices; a valid license; vehicle age (year 5 or newer); vehicle age (year 16 or newer); van; weekend driving; angle crash; off roadway crash; and front-seat occupants—were significant in the model for teenage drivers and their passengers but were not significant in the model for young-adult drivers and their passengers. On the other hand, the young-adult drivers and their passengers model identified eight significant explanatory variables that were not significant in the teenage drivers and their passengers model: inattention; alcohol/drug related crashes; disabling damage; destroyed damage; speed limit (< 35 mph); darkness; concrete roads; and female occupants.

Chapter 4 – Teenage and Young-Adult Survey about Distracted Driving

4.1 Introduction

Teenage and young-adult drivers' attitudes and behaviors associated with distracted driving and cell phone use while driving were studied by using survey questionnaires which can provide different perspective than using the crash database. The Kansas crash database does not provide more details related to the type of cell phone distraction such as making/receiving phone call or sending/reading text messages, and other distraction activities that drivers typically engage in while driving such as talking with passengers, eating/drinking, interacting with children in the back seat, doing personal grooming, changing radio stations or searching for CDs, and reading books or newspapers. These distracted driving activities were identified in previous studies as the most common activities that drivers typically engage in while driving [24, 25, and 26]. Consequently, more study using a survey of teenage and young-adult drivers was needed to understand the culture of distracted driving in the state of Kansas in more detail. This chapter provides detailed discussion of the methodology including survey form development used in this study and survey data collection as well as survey results and survey data analysis by using structural equation modeling (SEM).

4.2 Survey Development

A survey form was developed to provide all necessary information to understand the attitudes and behaviors associated with teenage and young-adult drivers' distractions that is similar to the procedures and categories used in the National Survey on Distracted Driving Attitudes and Behaviors study that was conducted in 2012 by the National Highway Traffic

Safety Administration [25]. There were nine questions based on categories that included demographic details (i.e., age, gender, education level, and annual income); driving information (i.e., frequency of driving, vehicle type, past traffic validation, and exposure to crashes and distraction -related crashes); and electronic devices ownership. However, the survey form developed for this study did not contain questions related the participants' name, date of birth, or any other personal identifiers. The survey form consisted of a total of 27 distracted driving related questions based on categories that included frequency of doing various distraction activities while driving and questions related to answering and making phone calls while driving, texting or e-mailing while driving, and distracted driving laws. Moreover, the survey form included five questions related to passengers' opinions on safety associated with distracted driving. Also, the survey form allowed respondents to skip subsequent questions if their answer was "never" for the following questions: frequency of driving, frequency of answering and making phone calls while driving, frequency of texting or e-mailing while driving, and others. The survey form is presented in Appendix B.

The survey form was pilot tested to evaluate the survey questions and to determine if any misunderstood questions and potential problems. Also, the other purpose of the pilot study was to identify the average time it would take to complete the survey. A pilot study was conducted with some graduate and undergraduate students at the Kansas State University. The results of the pilot study showed that the survey form was effective and only a few changes were necessary to be made. According to the results of the pilot study, questions about supporting Kansas law banning cell phone use while driving were included in the final survey form. Further, the results indicated that the survey takes an average about 10 to 12 minutes to complete.

4.3 Methodology and Data Collection

Risk factors among teenage (15–20 year old) and young-adult (21–26 year old) distracted drivers were identified in this study by conducting a survey in representative samples of graduate and undergraduate students at Kansas State University, Fort Hays State University, and the University of Kansas as well as high school students at Manhattan High School. The survey was collected either via an Internet data collection site (i.e., Qualtrics Survey Software) or survey forms distributed to participants. The questionnaire, data collection, and analyses were approved by the Kansas State University IRB (#8103). The IRB approval letter is included in Appendix C.

In terms of conducting a survey at Kansas State University, Fort Hays State University, and the University of Kansas, it was found that student organizations at these universities would be the best place to reach their students and collect the survey from them. The method of conducting the survey at these student organizations was by contacting the presidents/advisors of the student organizations via an e-mail and asking them first for permission to collect survey data from their organizations' members. Then they were asked if they have either regular meetings with students or an e-mail list of the students. If they have regular meetings with students, the survey was conducted by personally visiting these organization's meetings and distributing the printed survey forms to students. In case they have an e-mail list of the student members, the survey was conducted by sending a brief description of the study with the electronic link of the survey to the organizations' presidents/advisors and asking them to forward it to the students. Some surveys were also conducted at Kansas State University's Student Union. However, because most of the members of these student organizations are older than 17 years, these students may not represent a good blend of the entire teenage-driver population (15–20 year old), so a sample of Drivers Education students at Manhattan High School was considered as an alternative to reach this age group and eliminate possible biases.

Conducting a survey at Manhattan High School was challenging because they have very specific guidelines for conducting surveys with their students know as "USD 383's Research Request Packet Guidelines". In order to approve a request to conduct a survey with students, these guideline forms had to be filled out in their entirety as per instructions and some administration materials requirements had to be completed. After completing these guideline and administration materials requirements, the survey was reviewed by the Drivers Education teacher, the Principal, and USD383's Director of Teaching and Learning prior to making a decision to approve the study. Conducting the survey was eventually approved and the survey at Manhattan High School was conducted during two semesters, fall 2016 and spring 2017.

4.3.1 Subjects

The sample size was calculated by using the following equation;

$$n = \frac{\frac{Z^2 * p(1-p)}{e^2}}{1 + \left(\frac{Z^2 * p(1-p)}{e^2 N} \right)} \tag{4.1}$$

Where;

n = sample size,

N = the number of licensed young drivers in Kansas,

e = margin of error,

z = the number of standard deviations (z =1.96 for 95% confidence level), and

p = proportion of responses.

In 2014, the number of licensed young drivers was 318,691 in Kansas [64]. Based on number of licensed young drivers, 95% confidence level, and margin of error of 5%, the ideal sample size for this study is 384 or more. The sample size was calculated by using Qualtrics software.

The survey data were collected during a one-year period from March 10, 2016 to March 10, 2017. A total of 532 surveys were collected from throughout Kansas. However, data from those who were older than 26 years old (N=34); who completed only 25% of the survey questions (N=22); who reported never driving (N=20); and who didn't answer questions related to their age or gender (N=5) were excluded from further analysis. Consequently, survey responses from 451 young drivers (289 teenage drivers and 162 young-adult drivers) were used for detailed analysis in this study. It should be noted that the numbers and percentages of response frequency for some questions presented in this study may exceed the grand total who responded to the primary questionnaire item because some questions allowed multiple responses. In contrast, numbers of response frequency for certain survey questions may be less than the grand total who responded to the primary questionnaire items because some participants skipped or refused to answer some questions. Figure 4.1 shows the geographical distribution of the locations where the teenage and young-adult drivers' survey responses were collected.

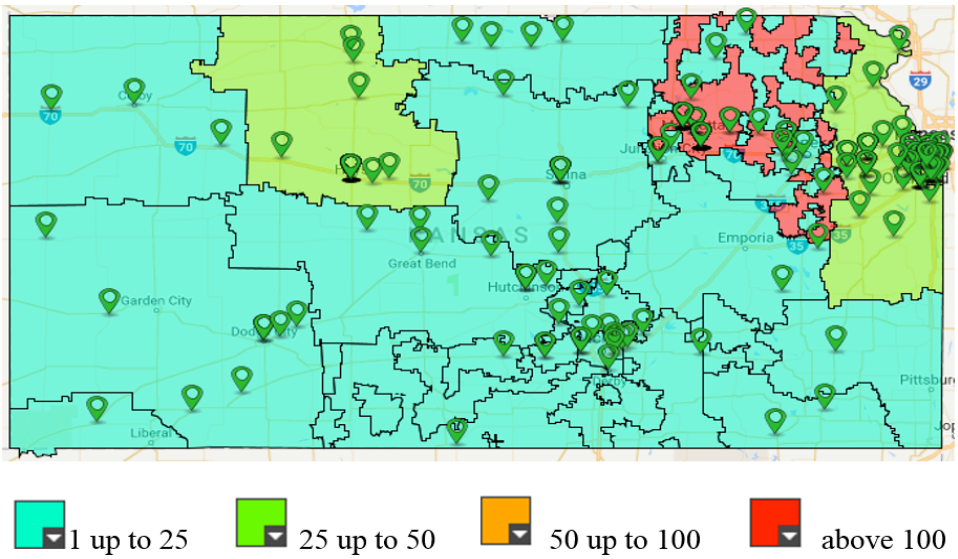


Figure 4.1 The Geographical Distribution of the Locations Where the Survey Data Were Collected

4.3.2 Likelihood of Occurrence

Likert Scale is widely used in questionnaires to obtain participant's attitudes and opinions to a specific question and combine into a single composite score known as "Likelihood of Occurrence" [67]. This could be accomplished by giving different weights to each participant's response to a certain question and assigned weights range from 0 to 100. Then, an average weighted value was calculated for each participant's response. Participants were asked to indicate their attitudes or opinions to a specific question by way of an ordinal scale. The first scale used in this study was a 5-point scale ranging from "never" on one end to "always" as shown in Table 4.2, and the other scale shown in Table 4.6 also contained of 5-point scale ranging from "don't know/missing" on one end to "very unsafe". For instance, the assigned weights are as follows: 0 for "never", 25 for "seldom", 50 for "sometimes", 75 for "almost always", and 100 for "always".

4.4 Survey Results

4.4.1 Demographics of Respondents

Table 4.1 shows frequencies and percentages for demographics characteristics, driving information, and electronic devices ownership for teenage and young-adult drivers who responded to the survey. About one-third of teenage participants drove few days a week, while the majority of young-adult participants drove every day or almost every day. In terms of the vehicle type the respondent recently drove, a large portion of teenage and young-adult drivers drove cars, whereas about 11% drove pickup trucks. Table 4.1 also shows that about one-fourth of teenage respondents' household income was less than $25K, while 4 in 10 young-adult respondents' household income was less than $25K. The most of the teenage and young-adult respondents owned cell phones or smartphones, or other electronic devices such as a portable music player and laptop computer. More than one-fourth of teenage and young-adult drivers have been involved in crashes or near-crashes during the last year. 19% of total teenage and young-adult drivers' crashes and near-crashes involved cell phones (e.g., talking or sending/reading text messages) related distracted driving.

Table 4.1 Demographics Characteristics, Driving Information, and Electronic Devices Ownership for Teenage and Young-Adult Drivers

Variable Description	Teenage Response Frequency (%)	Young-adult Response Frequency (%)
Gender [1:male, 2:female]	1: 129 (44.6%) 2: 160 (55.4%)	1: 75 (46.3%) 2: 87 (53.7%)
Q1. How often do you drive a motor vehicle? [1: never, 2: few days a year, 3: few days a month, 4: few days a week, 5: almost every day, 6: every day]	1: 0 (0.0%) 2: 13 (4.5%) 3: 40 (13.8%) 4: 93 (32.2%) 5: 64 (22.1%) 6: 79 (27.3%)	1: 0 (0.0%) 2: 3 (1.8%) 3: 4 (2.5%) 4: 27 (16.7%) 5: 43 (26.5%) 6: 85 (52.5%)
Q2. What type of vehicle did you recently drive? [1:car, 2:van, 3:motorcycle, 4:pickup truck, 5:sport utility vehicle, 6:other]	1: 217 (75.1%) 2: 8 (2.8%) 3: 0 (0.0%) 4: 33 (11.4%) 5: 24 (8.3%) 6: 7 (2.4%)	1: 124 (76.5%) 2: 3 (1.9%) 3: 2 (1.2%) 4: 17 (10.5%) 5: 14 (8.6%) 6: 2 (1.2%)
Q3. What is the highest level of education you have completed? [1: some high school, 2: some college, 3: some graduate school].	1: 90 (31.1%) 2: 199 (68.9%) 3: 0 (0.0%)	1: 0 (0.0%) 2: 148 (91.4%) 3: 14 (8.6%)
Q4. What is your approximate annual household income? [1: less than $25K, 2:$25K to less than $50K, 3: $50K to less than $100K, 4: $100K or more, 5:don't know]	1: 66 (22.8%) 2: 16 (5.5%) 3: 37 (12.8%) 4: 55 (19.0%) 5: 115 (39.8%)	1: 65 (40.1%) 2: 9 (5.6%) 3: 20 (12.3%) 4: 33 (20.4%) 5: 35 (21.6%)
Q6.a. Do you currently own a cell phone or smartphone? [1:no, 2:yes]	1: 6 (2.1%) 2: 283 (97.9%)	1: 1 (0.6%) 2: 161 (99.4%)
Q6.b. Do you currently own other electronic devices (e.g., portable music player and laptop computer)? [1:no, 2:yes]	1: 22 (7.6%) 2: 267 (92.4%)	1: 7 (4.3%) 2: 155 (95.7%)
Q6.c. Do you currently own in-car navigation systems? [1:no, 2:yes]	1: 237 (82.0%) 2: 52 (18.0%)	1: 139 (85.8%) 2: 23 (14.2%)
Q40. As a driver, have you been in a crash or near-crash during the last year? [1: no, 2:yes, crash, 3: yes, near-crash, 4: don't know]	1: 187 (73.0%) 2: 28 (10.9%) 3: 37 (14.5%) 4: 4 (1.6%)	1: 91 (65.0%) 2: 13 (9.3%) 3: 29 (20.7%) 4: 7 (5.0%)
Q41. As a driver, have you been in a crash or near-crash because of using a cell phone (e.g., talking or sending/reading text messages) during the last year? [1:no, 2:yes]	1: 53 (81.5%) 2: 12 (18.5%)	1: 34 (81.0%) 2: 8 (19.0%)

4.4.2 Teenage and Young-Adult Drivers Acceptability for Distracted Driving

Twelve questions about the frequency of teenage and young-adult drivers' acceptability for distracted driving are presented in Table 4.2. Moreover, Table 4.2 shows the likelihood of occurrence of distracted driving. Most of the teenage and young-adult drivers would always or almost always talk to their passengers while driving. In other words, according to the likelihood of occurrence value, there was a 76% chance for a teenage driver and a 78% chance for a young-adult driver to talk to passengers while driving. Similarly, there was about a 70% chance of a teenage and young-adult drivers adjusting the car radio, changing CDs, or using a portable music player while driving. In the case of eating or drinking while driving, nearly three-fourths of the teenage and young-adult participants stated that they eat or drink at least some of the time when driving. Chances of eating or drinking while driving were 45% for a teenage driver and 50% for a young-adult driver.

In addition, Table 4.2 shows that about 7 in 10 teenage respondents would at least sometimes accept phone calls while driving, whereas less than half of them would at least sometimes make phone calls while driving. Likewise, a majority of young-adult respondents would at least sometimes accept phone calls while driving, whereas only about 6 in 10 of them would at least sometimes make phone calls while driving. According to the likelihood of occurrence score, there was a 49% chance of a teenage driver accepting a phone call while driving, whereas in terms of making phone calls it came down to 36%. Similarity, there was a 57% chance of a young-adult driver accepting phone calls while driving, while in terms of making phone calls it came down to 46%.

In terms of reading or sending messages (text or e-mail) while driving, about 4 in 10 teenage respondents said that they read or send messages at least some of the time while driving, while about one-third of them stated that they never do so. However, approximately half of the

young-adult respondents said that they read or send messages at least some of the time while driving, while a few of them mentioned that they never do so. In other words, there was about a 30% chance of teenage drivers reading or sending messages while driving, whereas there was about a 40% chance that young-adult drivers did so. Analysis also revealed that there was more than a 50% chance that teenage and young-adult drivers used their smartphones for driving directions.

The chances that a teenage driver would be interacting with children in the back seat were 28%; using a navigation system (26%); doing personal grooming (12%); and reading (4%) while driving. The chances that a young-adult driver would be interacting with children in the back seat were 24%; using a navigation system (29%); doing personal grooming (19%); and reading (8%) while driving.

Table 4.2 Teenage and Young-Adult Drivers Acceptability for Distracted Driving

Q7. How often do you do the following activities	Teenage Drivers		Young-adult Drivers	
	Response Frequency (%)	Likelihood of Occurrence	Response Frequency (%)	Likelihood of Occurrence
a. Talk to passengers while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 3 (1.0%) 2: 18 (6.2%) 3: 55 (19.0%) 4: 99 (34.3%) 5: 114 (39.4%)	76	1: 1 (0.6%) 2: 6 (3.7%) 3: 30 (18.5%) 4: 58 (35.8%) 5: 67 (41.4%)	78
b. Change radio stations or searching for CDs while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 19 (6.6%) 2: 21 (7.3%) 3: 58 (20.1%) 4: 102 (35.3%) 5: 89 (30.8%)	69	1: 5 (3.1%) 2: 8 (4.9%) 3: 48 (29.6%) 4: 57 (35.2%) 5: 44 (27.2%)	70
c. Accept phone calls while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 74 (26.0%) 2: 18 (6.3%) 3: 95 (33.3%) 4: 46 (16.1%) 5: 52 (18.2%)	49	1: 13 (8.1%) 2: 19 (11.8%) 3: 67 (41.6%) 4: 35 (21.7%) 5: 27 (16.8%)	57
d. Use your cell phone for driving directions? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 43 (14.9%) 2: 24 (8.3%) 3:126 (43.6%) 4: 64 (22.1%) 5: 32 (11.1%)	52	1: 9 (5.6%) 2: 18 (11.1%) 3: 75 (46.3%) 4: 38 (23.5%) 5: 22 (13.6%)	57
e. Eat or drink while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 44 (15.2%) 2: 50 (17.3%) 3: 134 (46.4%) 4: 43 (14.9%) 5: 18 (6.2%)	45	1: 9 (5.6%) 2: 33 (20.4%) 3: 84 (51.9%) 4: 21 (13.0%) 5: 15 (9.3%)	50
f. Make phone calls while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 73 (26.1%) 2: 74 (26.4%) 3: 84 (30.0%) 4: 36 (12.9%) 5: 13 (4.6%)	36	1: 19 (11.9%) 2: 47 (29.4%) 3: 52 (32.5%) 4: 27 (16.9%) 5: 15 (9.4%)	46
g. Read messages while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 101 (35.8%) 2: 60 (21.3%) 3: 89 (31.6%) 4: 26 (9.2%) 5: 6 (2.1%)	30	1: 21 (13.2%) 2: 52 (32.7%) 3: 61 (38.4%) 4: 16 (10.1%) 5: 9 (5.7%)	41

Table 4.2 Teenage and Young-Adult Drivers Acceptability for Distracted Driving (continued)

Q7. How often do you do the following activities	Teenage Drivers		Young-adult Drivers	
	Response Frequency (%)	Likelihood of Occurrence	Response Frequency (%)	Likelihood of Occurrence
h. Send messages while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 92 (33.6%) 2: 73 (26.6%) 3: 75 (27.4%) 4: 20 (7.3%) 5: 14 (5.1%)	31	1: 28 (17.9%) 2: 50 (32.1%) 3: 57 (36.5%) 4: 14 (9.0%) 5: 7 (4.5%)	38
i. Use a navigation system while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 135 (46.7%) 2: 57 (19.5%) 3: 61 (21.1%) 4: 25 (8.7%) 5: 11 (3.8%)	26	1: 67 (41.4%) 2: 33 (20.4%) 3: 37 (22.8%) 4: 17 (10.5%) 5: 8 (4.9%)	29
j. Talk or interact with children in the back seat while driving? [1:always, 2:almost always, 3:sometimes, 4: seldom, 5:never]	1: 124 (43.1%) 2: 58 (20.1%) 3: 69 (24.0%) 4: 23 (8.0%) 5: 14 (4.9%)	28	1: 82 (50.9%) 2: 31 (19.3%) 3: 30 (18.6%) 4: 10 (6.2%) 5: 8 (5.0%)	24
k. Do personal grooming while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 197 (69.1%) 2: 56 (19.6%) 3: 23 (8.1%) 4: 6 (2.1%) 5: 3 (1.1%)	12	1: 87 (54.4%) 2: 39 (24.4%) 3: 21 (13.1%) 4: 9 (5.6%) 5: 4 (2.5%)	19
l. Read a book or newspaper while driving? [1:never, 2: seldom, 3:sometimes, 4: almost always, 5:always]	1: 257 (89.2%) 2: 20 (6.9%) 3: 9 (3.1%) 4: 0 (0.0%) 5: 2 (0.7%)	4	1: 131 (81.4%) 2: 15 (9.3%) 3: 10 (6.2%) 4: 2 (1.2%) 5: 3 (1.9%)	8

4.4.3 Teenage and Young-Adult Drivers' Behaviors after Accepting or Making Phone Calls While Driving

Behaviors after answering or making phone calls of teenage and young-adult drivers who reported accepting or making phone calls while driving are shown in Table 4.3. Additionally,

Table 4.3 summarizes the reasons that make teenage and young-adult drivers more likely to accept or make phone calls while driving. A large majority of teenage and young-adult drivers said that they accept a phone call and continue to drive while maintaining a conversation with the caller (80.1% and 83.8, respectively). About one-fourth of teenage and young-adult drivers ask their passenger to accept a phone call, and more than 12% accept and tell the caller they will call back later, whereas only a few of them pull over to a safe place after accepting the phone call or pull over to a safe place before accepting the phone call. In terms of method of accepting a phone call while driving, 70% of teenage and young-adult drivers accept phone calls and use a phone speaker system or other car features to stay hands-free while driving, while almost half of them stated that they use hand-held cell phones. Moreover, Table 4.3 shows that the major reason that makes teenage and young-adult drivers more likely to answer phone calls while driving is when they feel the call is important. This was followed by no traffic congestion, the call is from someone they know, the accessibility of the phone, no adverse weather conditions, and driving on roads with low speed limits.

Table 4.3 Teenage and Young-Adult Drivers' Behaviors after Accepting or Making Phone Calls While Driving

Variable Description	Teenage Drivers		Young-adult Drivers	
	Response Frequency	%	Response Frequency	%
Q10. When driving, do you usually… *				
Accept a phone call and complete the conversation while driving	164	77.7%	125	84.5%
Ask your passenger to accept the phone call	59	28.0%	36	24.3%
Accept a phone call and tell the caller you will call back later	26	12.3%	19	12.8%
Accept a phone call and then pull over to a safe place to complete the conversation	8	3.8%	6	4.1%
Pull over to a safe place and then accept the phone call	7	3.3%	2	1.4%
Q11. While driving, do you usually accept a phone call using: *				
Hands-free device	149	70.6%	105	70.9%
Hand-held device	96	45.5%	72	48.6%
Other	27	12.8%	18	12.2%
Q9. Under what situations do you accept a phone call while driving? *				
Importance of the call	169	80.1%	124	83.8%
No traffic congestion	90	42.7%	59	39.9%
Known caller	84	39.8%	52	35.1%
Accessibility of the phone	77	36.5%	48	32.4%
No adverse weather conditions	73	34.6%	41	27.7%
Driving on roads with low speed limits	68	32.2%	42	28.4%
Work-related call	64	30.3%	34	23.0%
Getting driving directions	63	29.9%	32	21.6%
No visible police officers	45	21.3%	32	21.6%
Other	149	70.6%	104	70.3%
Q14. While driving, do you usually make a phone call using: **				
Voice-dial	96	46.4%	58	41.1%
Manual dialing	67	32.4%	44	31.2%
Other (e.g., speed dial or favorites)	118	57.0%	87	61.7%

Table 4.3 Teenage and Young-Adult Drivers' Behaviors after Accepting or Making Phone Calls While Driving (continued)

Variable Description	Teenage Drivers		Young-adult Drivers	
	Response Frequency	%	Response Frequency	%
Q13. Under what situations do you make a call while driving? **				
Importance of the call	188	90.8%	120	85.1%
Getting driving directions	82	39.6%	42	29.8%
No traffic congestion	65	31.4%	47	33.3%
Safe to make a call	63	30.4%	49	34.8%
In an emergency	68	32.9%	30	21.3%
No adverse weather conditions	54	26.1%	35	24.8%
Accessibility of the phone	47	22.7%	32	22.7%
No visible police officers	31	15.0%	32	22.7%
Work-related call	44	21.3%	33	23.4%
Driving on roads with low speed limits	47	22.7%	24	17.0%
Other	110	53.1%	85	60.3%
Q15. How do you think your driving is affected when you are accepting or making a phone call? ***				
No effects	82	42.5%	69	51.1%
Drive at low speed	75	38.9%	41	30.4%
Look in mirrors more frequently	50	25.9%	33	24.4%
Increase gap distance from front vehicle	45	23.3%	34	25.2%
Reduce changing travel lanes	37	19.2%	26	19.3%
Avoid changing travel lanes	35	18.1%	14	10.4%
Drift off the lane or road	18	9.3%	13	9.6%
Use turn signal less frequently	11	5.7%	5	3.7%
Other	45	23.3%	21	15.6%
Q16. Under what circumstances you would never accept or make a phone call while driving? ***				
Merging with traffic	114	59.1%	68	50.4%
Adverse weather conditions	104	53.9%	81	60.0%
Visible police officers	99	51.3%	62	45.9%
Driving on roads with high speed limits	87	45.1%	55	40.7%
Driving in unfamiliar roads	52	26.9%	41	30.4%
Driving with a baby on board	56	29.0%	38	28.1%
Driving on curved roads	57	29.5%	32	23.7%
Driving in school zones	33	17.1%	26	19.3%
Driving in work zones	33	17.1%	18	13.3%
Driving at nighttime	27	14.0%	20	14.8%
Driving with adult passengers	21	10.9%	14	10.4%
Driving in neighborhoods or parking lots	13	6.7%	11	8.1%
Other	58	30.1%	44	32.6%

*Base: Accept phone call while driving at least seldom,
** Base: Make phone call while driving at least seldom, and
*** Base: Accept and make phone call while driving at least seldom.

In the case of making a phone call while driving, about one in two teenage and young-adult drivers said that they dial phone number by using voice dialing, while almost one-third of them stated that they dial the phone number manually. Moreover, Table 4.3 shows that the major reason that makes teenage and young-adult drivers more likely to make phone calls while driving is if they think it is important to make phone call. The second and third reasons that make teenage drivers more probable to make phone calls while driving were if they need of driving directions and report a traffic crash or medical emergency. However, the second and third common reasons that make young-adult drivers more likely to make phone calls while driving were if they think it's safe to call and if there are no traffic congestion. 22.7% of young-adult drivers mentioned that they are willing to make phone calls if there is no police officers in sight, while only 15.0% of teenage drivers are likely to do so.

The effects on driving behavior when teenage and young-adult drivers are answering or making phone calls are also shown in Table 4.3. More than 2 in 5 teenage drivers said that there is no effects, about 2 in 5 teenage drivers said that they drive slowly when they are answering or making phone calls, over 1 in 4 teenage drivers said that they look in their car mirrors more frequently, and almost 1 in 4 teenage drivers said that they may increase gap distance from front vehicle. In terms of young-adult drivers, more half of young-adult drivers mentioned that there is no effects, one-third of them mentioned that they drive slowly when they answer or make phone calls, about one-fourth of them mentioned that they may increase gap distance from front vehicle or look in their car mirrors more frequently.

Table 4.3 also shows the different driving circumstances in which teenage and young-adult drivers would never answer or make phone calls while driving. The highest percentage noted of driving circumstance in which teenage drivers would never answer or make phone calls

while driving include merging with traffic with 59.1%, followed by driving in adverse weather conditions, when they see a police officer, driving on roads with high speed limits. However, only 17.1% of teenage drivers stated that they never accept or make phone calls while driving in school or work zones. While, the highest percentage noted of driving circumstance in which young-adult drivers would never answer or make phone calls while driving include driving in adverse weather conditions with 60%, followed by merging with traffic, when they see a police officer, driving on roads with high speed limits. In addition, nearly 2 in 10 young-adult drivers stated that they never accept or make phone calls while driving in school zones, whereas only 13.3% of them stated that they never accept or make phone calls while driving in work zones.

4.4.4 Teenage and Young-Adult Drivers' Behaviors after Texting or E-mailing While Driving

Behaviors of teenage and young-adult drivers who reported sending messages (text or e-mail) while driving are shown in Table 4.4. Half of teenage and young-adult drivers stated that they continue to drive while sending messages. Over 2 in 5 teenage and young-adult (43.8%) drivers stated that they send a message while stopping at a red light or stop sign, and about 2 out of 5 teenage and young-adult drivers stated that they ask their passengers to send messages for them. More than one-fourth of teenage and young-adult drivers stated that they use a voice command feature to send messages, whereas only a few of them stated that they pull over to a safe place to send messages.

Additionally, Table 4.4 summarizes the reasons that make teenage and young-adult drivers more probable to send messages while driving. Teenage and young-adult drivers mentioned that the major reason that makes them more likely to send messages while driving is if they think the message is important. This was followed by no traffic congestion, if they think

it's safe to send a message, if they need driving directions, no adverse weather conditions, and driving on roads with low speed limits. In addition, over one-fourth of teenage and young-adult drivers mentioned that they are willing to send text messages or e-mails while driving if there is no visible police officers.

Table 4.4 also shows the effects on driving behavior when teenage and young-adult drivers are sending messages while driving. A majority of teenage and young-adult drivers stated that they drive slowly when they are sending messages, and more than one-fourth of them stated that they may increase gap distance from front vehicle. More than 23% of teenage and young-adult drivers stated that they drift off the lane or road when they are sending messages, while 20.3% of them believe that there is no effects.

Different driving circumstances in which teenage and young-adult drivers would never send messages while driving are presented in Table 4.4. The most common driving circumstance in which teenage and young-adult drivers would never send messages while driving include merging with traffic, followed by driving in adverse weather conditions, when they see a police officer, and driving on roads with high speed limits. However, only 28% of teenage drivers said that they never send messages while driving near schools or work zones. In addition, about one-third of young-adult drivers said that they never send messages while driving in school zones, whereas only 27.3% of them said that they never send messages while driving in work zones.

Table 4.4 Teenage and Young-Adult Drivers' Behaviors after Texting While Driving

Variable Description	Teenage Drivers		Young-adult Drivers	
	Response Frequency	%	Response Frequency	%
Q19. When driving, do you usually… *				
Continue to drive while sending a message	101	55.5%	64	50.0%
Send a message while stopping at a red light or stop sign	75	41.2%	56	43.8%
Ask your passenger to send the message	71	39.0%	52	40.6%
Use a voice command feature (speech dictation) to send the message	50	27.5%	39	30.5%
Pull over to a safe place and then send the message	19	10.4%	6	4.7%
Q20. Under what situations do you send a message while driving? *				
Importance of the message	164	90.1%	114	89.1%
No traffic congestion	61	33.5%	53	41.4%
Safe to send a message	60	33.0%	43	33.6%
Getting driving directions	54	29.7%	43	33.6%
No adverse weather conditions	52	28.6%	39	30.5%
Driving on roads with low speed limits	50	27.5%	35	27.3%
No visible police officers	46	25.3%	33	25.8%
Work-related	34	18.7%	27	21.1%
In an emergency	28	15.4%	15	11.7%
Other	71	39.0%	56	43.8%
Q21. How do you think your driving is affected when you are sending messages? *				
Drive at low speed	110	60.4%	74	57.8%
Increase gap distance from front vehicle	48	26.4%	33	25.8%
Drift off the lane or road	42	23.1%	30	23.4%
No effects	37	20.3%	26	20.3%
Look in mirrors more frequently	36	19.8%	28	21.9%
Avoid changing travel lanes	35	19.2%	24	18.8%
Reduce changing travel lanes	35	19.2%	22	17.2%
Apply the brakes suddenly	29	15.9%	16	12.5%
Other	47	25.8%	28	21.9%

Table 4.4 Teenage and Young-Adult Drivers' Behaviors after Texting While Driving (continued)

Variable Description	Teenage Drivers		Young-adult Drivers	
	Response Frequency	%	Response Frequency	%
Q22. Under what circumstances you would never send a message while driving? *				
Merging with traffic	123	67.6%	84	65.6%
Adverse weather conditions	114	62.6%	76	59.4%
Visible police officers	106	58.2%	74	57.8%
Driving on roads with high speed limits	98	53.8%	67	52.3%
Driving with a baby on board	84	46.2%	64	50.0%
Driving in unfamiliar roads	74	40.7%	56	43.8%
Driving on curved roads	76	41.8%	52	40.6%
Driving in school zones	52	28.6%	43	33.6%
Driving at nighttime	43	23.6%	37	28.9%
Driving in work zones	51	28.0%	35	27.3%
Driving with adult passengers	42	23.1%	25	19.5%
Driving in neighborhoods or parking lots	29	15.9%	23	18.0%
Other	41	22.5%	27	21.1%

*Base: Send a message while driving at least seldom.

4.4.5 Educational Messages and Laws to Reduce Distracted Driving

Educational messages, and countermeasures of laws (i.e., enforcements and sanctions) that would help to reduce distracted driving are shown in Table 4.5. Overall, nearly three-fourths of teenage and young-adult drivers said that they had seen or heard educational messages that warn about the potential hazards of using a cell phone (e.g., talking or sending/reading text messages) while driving. Regarding talking or sending/reading text message bans, more than half of teenage and young-adult drivers mentioned that they have a law in their areas banning talking on a hand-held cell phone while driving, whereas more than 1 in 10 teenage drivers, and more than 1.5 in 10 young-adult drivers reported that they don't know. Likewise, a majority of teenage and young-adult drivers mentioned that they have a law in their areas banning texting while driving, whereas about 1 in 10 teenage drivers and young-adult drivers said that they don't know. In terms

of support for Kansas law banning talking or sending/reading text messages, only 45% of teenage and young-adult drivers stated that they support a Kansas law banning talking on a hand-held cell phone while driving that apply to some cities, while a high majority of them stated that they support Kansas law banning sending/reading text messages while driving. Table 4.5 shows that most of teenage and young-adult drivers had a traffic violation because of speeding, whereas hand-held cell phone use such as talking or sending/reading text messages while driving had the second largest percentage. About three-fourths of teenage and young-adult drivers had a traffic violation that resulted in a ticket or warning because of using a handheld cell phone while driving.

Further, the survey also evaluated whether the educational messages, and countermeasures of laws would help reduce teenage and young-adult drivers' distracted driving behaviors. Almost one-third of teenage drivers said that their frequency of using cell phones (e.g., talking or sending/reading text messages) while driving is the same now as it was in the last year, while one-fourth of them did report a decrease. However, nearly half of young-adult drivers said that their frequency of using a cell phone (e.g., talking or sending/reading text messages) while driving has stayed the same, whereas about one-third of them did report a decrease.

The reasons for the decrease in using a cell phone such as talking or sending/reading text messages while driving given by teenage and young-adult drivers who reported a decrease in using cell phones in the last year are also shown in Table 4.5. More than two-thirds of teenage drivers said that the reason for the decrease in talking on the cell phone while driving was a law that bans cell phone use, while 4 in 10 teenage drivers said that the reason was an increased awareness about the hazards of using a cell phone while driving. However, 59.1% of young-adult drivers mentioned that a law that bans cell phone use, and an increased awareness about the

hazards of using a cell phone while driving were the most reasons. In case of sending and reading messages while driving, approximately two-thirds of teenage and young-adult drivers said that the most reasons for the decrease in sending and reading messages while driving were a law that bans cell phone use, and an increased awareness about the hazards of using a cell phone while driving. As a passenger, nearly two-thirds of the teenage and young-adult participants would at least sometimes do or say something to their distracted drivers to stop talking on hand-held cell phones while driving. However, most of them as passengers would at least sometimes do or say something to their drivers to stop sending messages while driving.

Table 4.5 Educational Messages and Laws to Reduce Distracted Driving

Variable Description	Teenage Driver Frequency (%)	Young-adult Driver Frequency (%)
Q23. Recently, have you seen or heard educational messages that warn about the potential hazards of using a cell phone (e.g., talking or sending/reading text messages) while driving? [1: no, 2: yes, 3:don't know]	1: 58 (21.3%) 2: 191 (70.2%) 3: 23 (8.5%)	1: 24 (16.1%) 2: 110 (73.8%) 3: 15 (10.1%)
Q34. Do you have a law in your area banning hand-held cell phone use while driving? [1: no, 2: yes, I think so, 3: yes, 4:don't know]	1: 32 (12.4%) 2: 59 (22.9%) 3: 140 (54.3%) 4: 27 (10.5%)	1: 17 (12.0%) 2: 18 (12.7%) 3: 84 (59.2%) 4: 23 (16.2%)
Q35. Do you have a law in your area banning texting while driving? [1: no, 2: yes, I think so, 3: yes, 4:don't know]	1: 6 (2.3%) 2: 55 (21.5%) 3: 172 (67.2%) 4: 23 (9.0%)	1: 6 (4.2%) 2: 17 (12.0%) 3: 104 (73.2%) 4: 15 (10.6%)
Q36. Do you support a Kansas law banning hand-held cell phone use while driving that applied to some cities? [1:no, 2: yes, 3:don't know]	1: 77 (29.8%) 2: 120 (46.5%) 3: 61 (23.6%)	1: 44 (31.0%) 2: 65 (45.8%) 3: 33 (23.2%)
Q37. Do you support a Kansas law banning texting while driving? [1:no, 2: yes, 3:don't know]	1: 19 (7.4%) 2: 206 (79.8%) 3: 33 (12.8%)	1: 13 (9.2%) 2: 108 (76.1%) 3: 21 (14.8%)
Q38. As a driver, have you ever had a traffic violation because of? [1:speeding, 2: hand-held cell phone use (e.g., talking or sending/reading text messages), 3:other (e.g., seat belt violation, drunk driving, reckless driving, expired tags/ license, 4:never]	1: 257 (88.9%) 2: 15 (5.2%) 3: 14 (4.8%) 4: 3 (1.0%)	1: 142 (87.7%) 2: 12 (7.4%) 3: 6 (3.7%) 4: 2 (1.2%)
Q39. As a driver, have you ever had a traffic violation that resulted in a ticket or warning because of using a handheld cell phone (e.g., talking or sending/reading text messages) while driving? [1: no, 2:yes]*	1: 4 (26.7%) 2: 11 (73.3%)	1: 3 (25.0%) 2: 9 (75.0%)
Q30. In the last year, has your frequency of talking on cell phone while driving changed? [1:increased, 2:decreased, 3:no change, 4:never talk on cell phone while driving, 5: don't know]	1: 34 (12.9%) 2: 67 (25.5%) 3: 89 (33.8%) 4: 36 (13.7%) 5: 37 (14.1%)	1: 16 (11.1%) 2: 44 (30.6%) 3: 71 (49.3%) 4: 1 (0.7%) 5: 12 (8.3%)
Q31. Is your frequency of talking on cell phone while driving decreased due to: [1:increased awareness about the hazards of using a cell phone while driving, 2: cell phone use while driving bans, 3:been in a crash, 4: other] [Multiple Record]**	1: 27 (40.3%) 2: 43 (64.2%) 3: 9 (13.4%) 4: 24 (35.8%)	1: 26 (59.1%) 2: 26 (59.1%) 3: 5 (11.4%) 4: 12 (27.3%)

Table 4.5 Educational Messages and Laws to Reduce Distracted Driving (continued)

Variable Description	Teenage Driver Frequency (%)	Young-adult Driver Frequency (%)
Q32. In the last year, has your frequency of texting while driving changed? [1:increased, 2:decreased, 3:no change, 4:never texting while driving, 5: don't know]	1: 29 (11.6%) 2: 66 (26.4%) 3: 76 (30.4%) 4: 43 (17.2%) 5: 36 (14.4%)	1: 9 (6.5%) 2: 51 (36.7%) 3: 67 (48.2%) 4: 3 (2.2%) 5: 9 (6.5%)
Q33. Is your frequency of texting while driving decreased due to: [1:increased awareness about the hazards of using a cell phone while driving, 2: cell phone use while driving bans, 3:been in a crash, 4: other] [Multiple Record]***	1: 40 (60.6%) 2: 43 (65.2%) 3: 11 (16.7%) 4: 21 (31.8%)	1: 31 (60.8%) 2: 35 (68.6%) 3: 5 (9.8%) 4: 11 (21.6%)
Q26. As a passenger, how often do you do or say something to your distracted driver to stop talking on a hand-held cell phone while driving? [1:always, 2:almost always, 3:sometimes, 4:seldom, 5:never, 6: don't know]	1: 32 (11.9%) 2: 68 (25.4%) 3: 64 (23.9%) 4: 59 (22.0%) 5: 30 (11.2%) 6: 15 (5.6%)	1: 11 (7.6%) 2: 36 (25.0%) 3: 46 (31.9%) 4: 29 (20.1%) 5: 15 (10.4%) 6: 7 (4.9%)
Q28. As a passenger, how often do you do or say something to your distracted driver to stop texting while driving? [1:always, 2:almost always, 3:sometimes, 4:seldom, 5:never, 6: don't know]	1: 94 (35.3%) 2: 86 (32.3%) 3: 42 (15.8%) 4: 26 (9.8%) 5: 8 (3.0%) 6: 10 (3.8%)	1: 39 (27.3%) 2: 49 (34.3%) 3: 31 (21.7%) 4: 13 (9.1%) 5: 5 (3.5%) 6: 6 (4.2%)

*Base: Drivers who had a traffic violation because of using hand-held cell phones while driving,
** Base: Drivers who reported a decrease in the frequency of talking on cell phone while driving in the last year, and
*** Base: Drivers who reported a decrease in the frequency of texting while driving in the last year.

4.4.6 Teenage and Young-Adult Passengers' Opinions on Safety of Distracted driving

As a passenger, teenage and young-adult respondents' opinion on safety if their drivers were doing other activities while driving, were also solicited in the survey. A large majority of teenage and young-adult passengers said that they felt unsafe if their driver was using a laptop computer, watching a movie, or reading while driving. Additionally, about three-fourths of teenage passengers rated sending or reading messages, doing personal grooming, or using a music player as unsafe, while nearly two-thirds of young-adult passengers rated them as unsafe. Approximately one half of teenage and young-adult passengers said that they felt unsafe if their drivers were using a navigation system, talking on a hand-held cell phone, or dealing with

children in the back seat. Meanwhile, 44% of teenage passengers would feel unsafe if their drivers were eating or drinking while driving, whereas 41% of young-adult passengers would feel unsafe if their drivers were doing so. Moreover, approximately one-third of teenage and young-adult passengers stated that they felt unsafe if their drivers were distracted by vehicle items, talking on cell phones with hands-free devices, or talking to passengers. Driver singing along to a song on the radio ranked last with about one-fourth of teenage and young-adult passengers rating it as unsafe. In general, teenage passengers would feel unsafe more than young-adult passengers if their drivers were doing other activities while driving as listed in Table 4.6.

Table 4.6 Teenage and Young-Adult Passengers' Opinions on Safety of Distracted driving

Q25. As a passenger, how safe you would feel when your driver was doing the following distracting activities?	Teenage Passenger		Young-adult Passenger	
	Response Frequency (%)	Likelihood of Occurrence	Response Frequency (%)	Likelihood of Occurrence
l. Using a laptop computer [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:214 (74.0%) 2:28 (9.7%) 3:16 (5.5%) 4:6 (2.1%) 5:25 (8.7%)	85	1:114 (70.4%) 2:14 (8.6%) 3:9 (5.6%) 4:4 (2.5%0 5:21 (13.0%)	80
o. Watching a movie [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:216 (74.7%) 2:24 (8.3%) 3:15 (5.2%) 4:9 (3.1%) 5:25 (8.7%)	84	1:119 (73.5%) 2:11 (6.8%) 3:9 (5.6%) 4:4 (2.5%) 5:19 (11.7%)	82
e. Reading a book or newspaper [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:212 (73.4%) 2:30 (10.4%) 3:11 (3.8%) 4:10 (3.5%) 5:26 (9.0%)	84	1:106 (65.4%) 2:23 (14.2%) 3:8 (4.9%) 4:5 (3.1%) 5:20 (12.3%)	79
g. Sending messages [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:131 (45.3%) 2:86 (29.8%) 3:36 (12.5%) 4:12 (4.2%) 5:24 (8.3%)	75	1:57 (35.2%) 2:56 (34.6%) 3:21 (13.0%) 4:7 (4.3%) 5:21 (13.0%)	69
f. Reading messages [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:124 (42.9%) 2:90 (31.1%) 3:37 (12.8%) 4:12 (4.2%) 5:26 (9.0%)	74	1:53 (32.7%) 2:63 (38.9%) 3:22 (13.6%) 4:5 (3.1%) 5:19 (11.7%)	69
i. Doing personal grooming [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:127 (43.9%) 2:85 (29.4%) 3:38 (13.1%) 4:12 (4.2%) 5:27 (9.3%)	74	1:59 (36.4%) 2:48 (29.6%) 3:31 (19.1%) 4:3 (1.9%) 5:21 (13.0%)	69
m. Using a music player [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:117 (40.5%) 2:76 (26.3%) 3:42 (14.5%) 4:27 (9.3%) 5:27 (9.3%)	70	1:58 (35.8%) 2:48 (29.6%) 3:23 (14.2%) 4:12 (7.4%) 5:21 (13.0%)	67
n. Using a navigation system [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:38 (13.1%) 2:77 (26.6%) 3:106 (36.7%) 4:41 (14.2%) 5:27 (9.3%)	55	1:15 (9.3%) 2:52 (32.1%) 3:59 (36.4%) 4:16 (9.9%) 5:20 (12.3%)	54

Table 4.6 Teenage and Young-Adult Passengers' Opinions on Safety of Distracted driving (continued)

Q25. As a passenger, how safe you would feel when your driver was doing the following distracting activities?	Teenage Passenger		Young-adult Passenger	
	Response Frequency (%)	Likelihood of Occurrence	Response Frequency (%)	Likelihood of Occurrence
c. Talking on a hand-held cell phone [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:33 (11.4%) 2:85 (29.4%) 3:100 (34.6%) 4:43 (14.9%) 5:28 (9.7%)	54	1:14 (8.6%) 2:38 (23.5%) 3:55 (34.0%) 4:33 (20.4%) 5:22 (13.6%)	48
h. Dealing with children in the back seat [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:26 (9.0%) 2:47 (16.3%) 3:114 (39.4%) 4:76 (26.3%) 5:26 (9.0%)	47	1:16 (9.9%) 2:33 (20.4%) 3:51 (31.5%) 4:40 (24.7%0 5:22 (13.6%)	47
b. Eating or drinking [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:13 (4.5%) 2:43 (14.9%) 3:124 (42.9%) 4:82 (28.4%) 5:27 (9.3%)	44	1:6 (3.7%) 2:19 (11.7%) 3:67 (41.4%) 4:51 (31.5%) 5:19 (11.7%)	41
j. Distracting in the vehicle items (i.e., adjusting the car radio, tape, or CD player) [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:17 (5.9%) 2:23 (8.0%) 3:85 (29.4%) 4:141 (48.8%) 5:23 (8.0%)	39	1:4 (2.5%) 2:16 (9.9%) 3:46 (28.4%) 4:73 (45.1%) 5:23 (14.2%)	35
d. Talking on the phone with a hands free device [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:11 (3.8%) 2:23 (8.0%) 3:74 (25.6%) 4:155 (53.6%) 5:26 (9.0%)	36	1:5 (3.1%) 2:15 (9.3%) 3:36 (22.2%) 4:86 (53.1%) 5:20 (12.3%)	34
a. Talking to passengers [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:14 (4.8%) 2:17 (5.9%) 3:50 (17.3%) 4:182 (63.0%) 5:26 (9.0%)	34	1:6 (3.7%) 2:12 (7.4%) 3:21 (13.0%) 4:105 (64.8%) 5:18 (11.1%)	32
k. Singing [1:very unsafe, 2: unsafe, 3: safe, 4: very safe, 5: don't know/missing]	1:15 (5.2%) 2:9 (3.1%) 3:36 (12.5%) 4:197 (68.2%) 5:32 (11.1%)	31	1:4 (2.5%) 2:8 (4.9%) 3:11 (6.8%) 4:113 (69.8%) 5:26 (16.0%)	27

4.4.7 Descriptive Results

The main purpose of the descriptive results of cell phone use and passengers-related distractions was to provide a better view of the characteristics of these distraction activities as they relate with other factors.

4.4.7.1 The Likelihood of Cell Phone Use While Driving

Figure 4.2 illustrates the relationship between cell phone use while driving and gender of teenage and young-adult drivers, which shows that male teenage drivers have higher chance of using cell phone while operating the vehicles than female teenage drivers. However, female young-adult drivers have higher chance of using their cell phones while driving than male young-adult drivers. Therefore, male teenage and female young-adult drivers are more engaged in their cell phones while driving than female teenage and male young-adult drivers.

Figure 4.3 shows the relationship between cell phone use while driving and driving frequency. The results show in general that teenage and young-adult drivers who drove every day or almost every day and teenage and young-adult drivers who drove a few days a month or a few days a year are more likely to engage in cell phone use while driving than those who drove a few days a week.

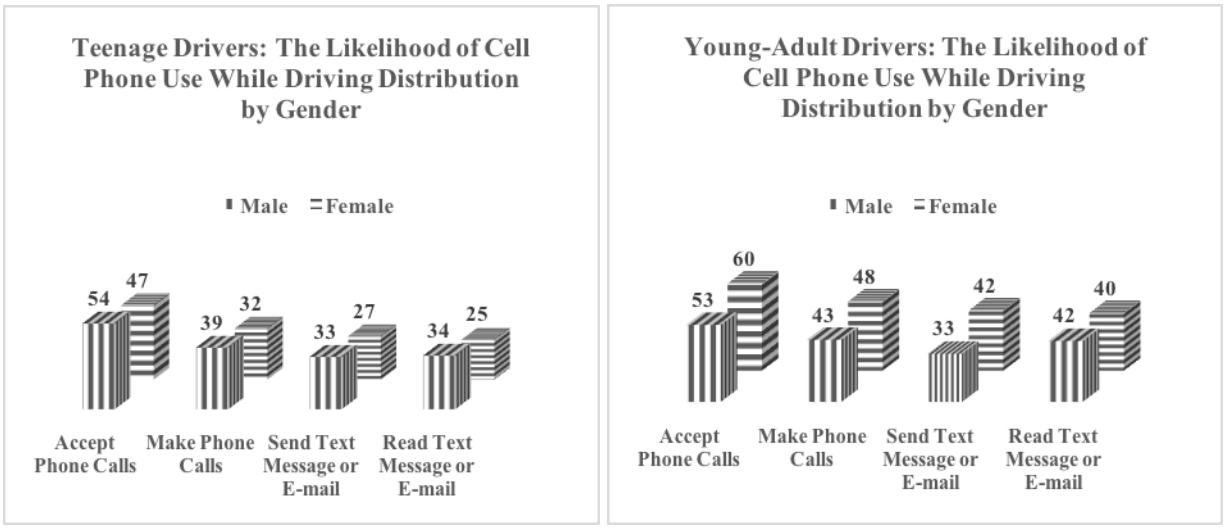


Figure 4.2 The Likelihood of Cell Phone Use While Driving by Gender

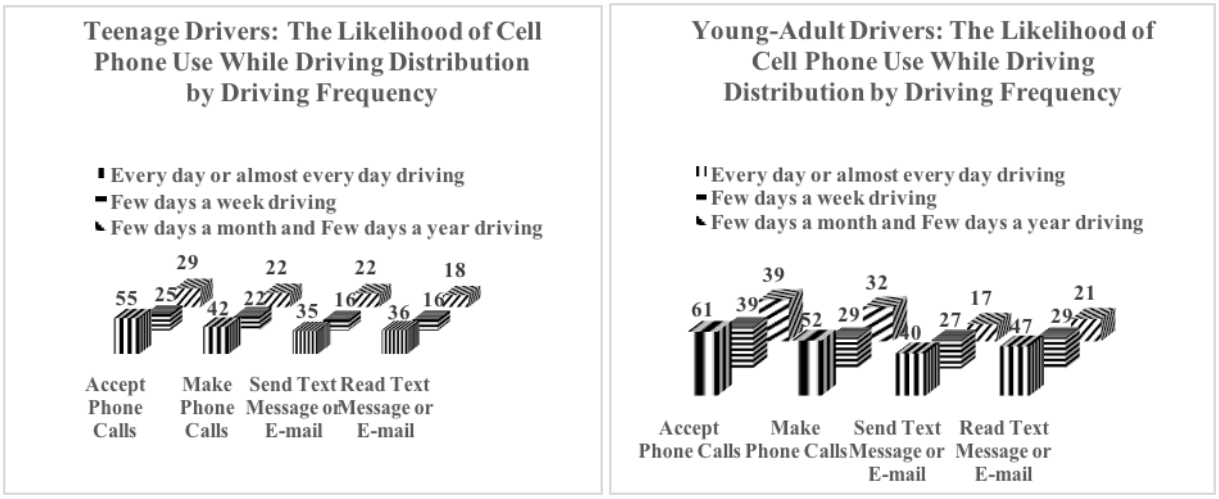


Figure 4.3 The Likelihood of Cell Phone Use While Driving by Driving Frequency

4.4.7.2 The Likelihood of Talking to Passengers While Driving

The relationship between talking to passengers while driving and gender of teenage and young-adult drivers is shown in Figure 4.4. The results reveal that male teenage and female young-adult drivers have the highest chance of talking to their passengers while operating the vehicles than female teenage and male young-adult drivers. Furthermore, Figure 4.5 displays the likelihood of talking to passengers while driving as it relate with driving frequency. These results clearly show

that the likelihood of talking to passengers while driving gradually increases as driving frequency increases.

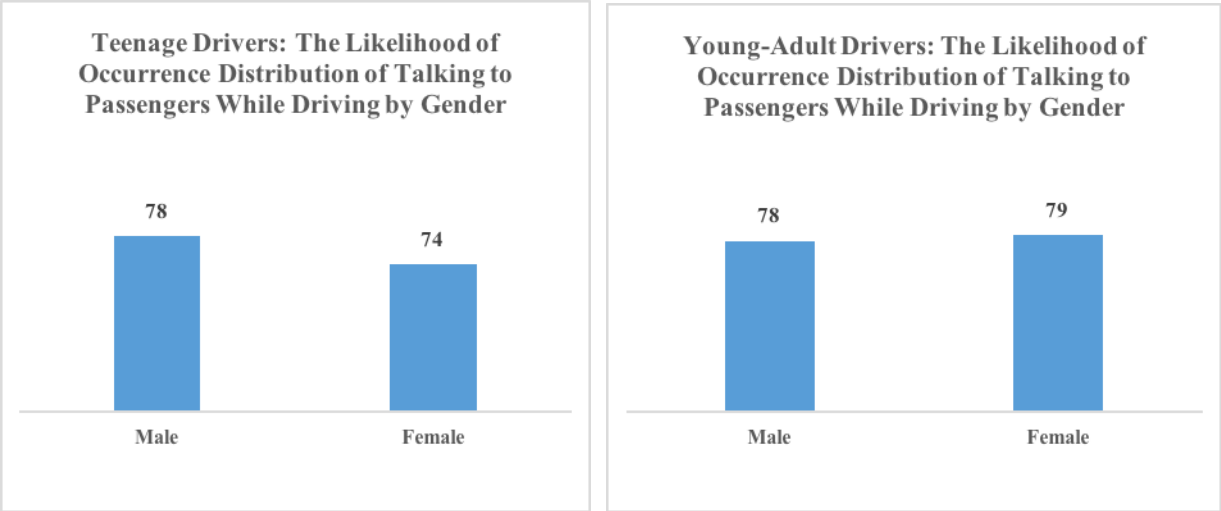


Figure 4.4 The Likelihood of Talking to Passengers While Driving by Gender

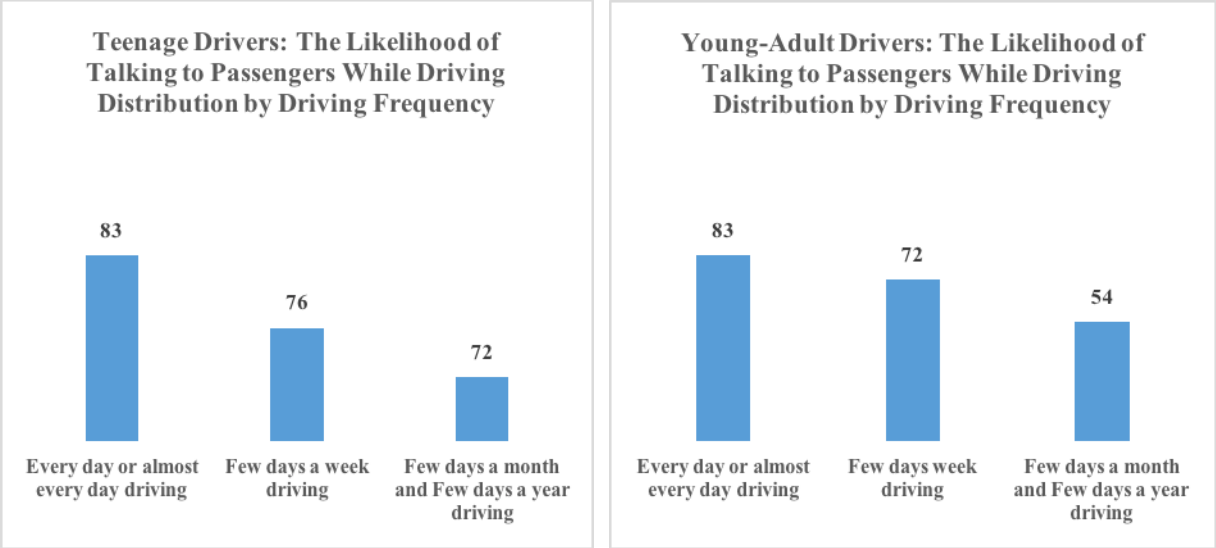


Figure 4.5 The Likelihood of Talking to Passengers While Driving by Driving Frequency

4.5 Survey Data Analysis

The survey data were analyzed using structural equation modeling (SEM) to identify the relationship between young (15–26 years old) drivers' characteristics such as demographic and socioeconomic status, attitudes, and behaviors associated with distracted driving and cell phone use (e.g., talking or sending/reading text messages) while driving.

4.5.1 Structural Equation Modeling (SEM)

A structural equation modeling (SEM) is a comprehensive statistical analysis technique that is the combination of analysis of variance (ANOVA) and multiple regression analysis [68]. In addition, SEM has three of the well-known analysis methods which include confirmatory factor analysis, latent variable modeling, and path analysis [69]. A structural equation modeling (SEM) is widely used to analyze relationships among one or more exogenous (independent) variables and endogenous (dependent) variables as well as latent (unobserved) variables. Latent variables are opposed to observable variables which can't be measured directly from the dataset. However, latent variables can be assessed by using one or multiple indicators (measured variables).

A structural equation modeling (SEM) is broadly used in distracted driving and traffic safety studies. Li, Wanjun, Gkritza, and Albrecht used structural equation modeling to examine the association between volunteer drivers' socioeconomic and demographic status and attitudes and experiences on distracted driving in the state of Iowa [24]. Another study used SEM to estimate the associations among perception of risk, emotionality of the call, and frequency and importance of accepting and making a phone call while driving [70]. Furthermore, Golob, and Hensher used SEM to test the influences of long distance truck drivers adhering to their schedules on drug use and speeding violations [71]. A study conducted in Canada to examine the

association between latent variables (demographic and socioeconomic characteristics), land use patterns, and travel behavior by using SEM [72].

4.5.1.1 Advantages of Using SEM and Differences of SEM from Traditional Statistical Models

- SEM is an adequate and flexible methodology to model the complex relationships among observed variables and variables that can be hypothetical or unobserved (latent variables),
- SEM has related equations to estimate all parameters in the model simultaneously,
- Due to SEM using distinct latent constructs, problems of multicollinearity cannot occur,
- SEM isn't a default model which allows researchers to specify the model that is to be estimated and identify the types of relationships can be tested, and
- SEM evaluates measurement error and thus the ability to obtain more valid parameters.

4.5.1.2 Model Specification and Identification

Structural equation modeling (SEM) has two components that include a measurement (sub) model and a structural (sub) model. SEM measurement model (confirmatory factor analysis) examines the relationship between observed variables and latent variables to analyze how various observed variables measure latent variables as linear functions (weighted averages). In addition, the measurement model reduces measurement errors of observed variables that affect the accuracy of coefficients and standard errors of latent variables by having several measures per latent variable.

SEM measurement model is composed of two sets of simultaneous equations include SEM measurement model for latent endogenous variables (η) and SEM measurement model for latent exogenous variables (ξ);

$$y = \Lambda_y \eta + \varepsilon \quad (4.2)$$

$$x = \Lambda_x \xi + \delta \quad (4.3)$$

Where,

y = indicators of η,

Λ_y = factor loadings of η on y (λ_4, λ_5,……, λ_{11}),

ε = measurement error for y,

x = indicators of ξ,

Λ_x = factor loadings of ξ on x (λ_1, λ_3, and λ_3), and

δ = measurement error for x.

While SEM structural model (latent variable model) examines the relationship between latent variables to measure the causal influences or regression effects of latent variables upon one another [73]. SEM structural model is given by;

$$\eta = \beta\eta + \gamma\xi + \zeta \quad (4.4)$$

Where,

η= latent endogenous variables,

ξ = latent exogenous variables,

ζ = vector of disturbances,

β = coefficient for η on η effects, and

γ =coefficient for ξ on η effects.

It should be noted that η is on both sides of the equation, because dependent variables are a function of the endogenous regression effects on themselves in the SEM structural model plus the exogenous regression effects on the endogenous variable plus the measurement error.

Another analysis method of structural equation modeling is the path analysis (graphical representation) by manipulating arrows in a path (flow) diagram as shown in Figure 4.6. There are direct effects and indirect effects relationship in a path diagram [74 and 69]. Direct effects represent the links between one variable to another by straight (single-headed) arrows. Indirect effects are defined as the effects along the paths among the two variables that involve intervening variables. Consequently, total effects are the sum of direct effects and indirect effects. In addition, curves with arrow-heads on both sides represent covariance between two latent variables or measurement error terms of observed variables. The symbols that are used to draw path diagram of structural equation modeling (SEM) include:

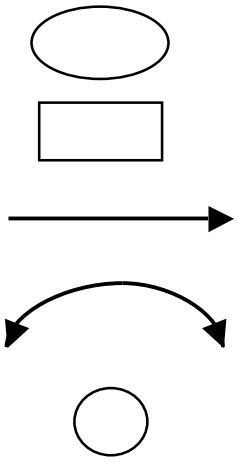
Latent variables:

Observed (measured, indicators) variables:

Hypothesized predictive relationship (regression):

Correlation between two variables:

Measurement error:



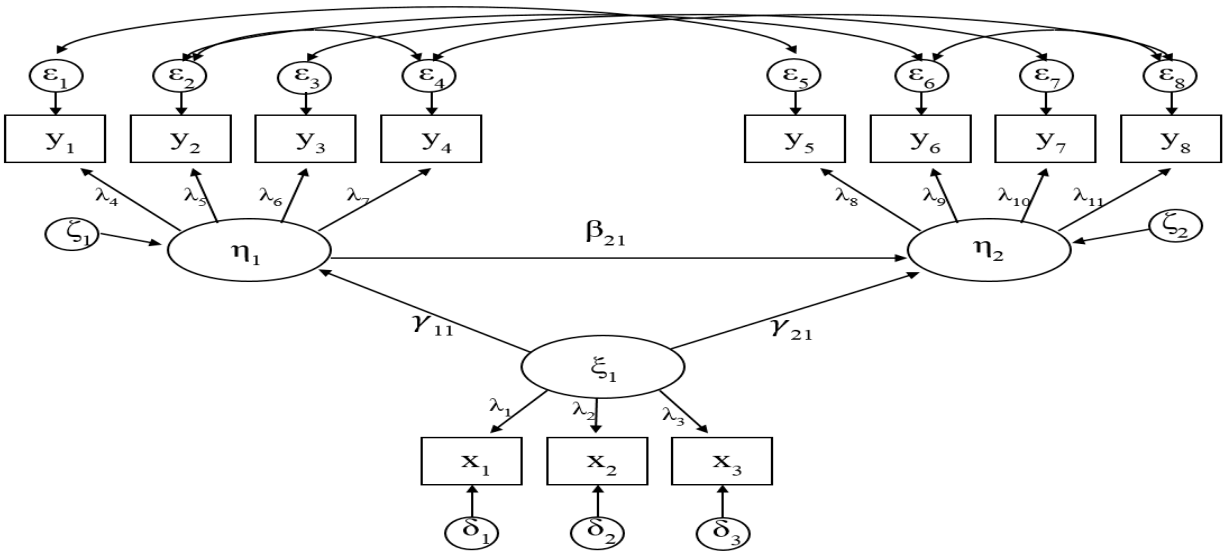


Figure 4.6 Example Path Analysis Diagram of Structural Equation Modeling

4.5.1.3 Model Evaluation (Goodness-of-Fit)

A minimum sample size requirements to achieve an acceptable SEM is 200 observations [75] or five observations per parameter in the model [76], according to the literature.

There are several indices which can be used to evaluate SEM model fit. The most common fit indices are standardized root mean square residual (SRMR), comparative fit index (CFI), and root mean square error of approximation (RMSEA).

4.5.1.3.1 Standardized Root Mean Square Residual (SRMR)

SRMR is achieved by measuring the average difference between the observed covariance matrix and predicted covariance matrix. SRMR value less than or equal to 0.08 is suggested as a good fit model [77].

4.5.1.3.2 Comparative Fit Index (CFI)

CFI compares the proposed model (current model) with the null model. The model with CFI value close to 0.90 or above is considered as a preferred model fit [77].

4.5.1.3.3 Root Mean Square Error of Approximation (RMSEA)

RMSEA compares the saturated model in which all variables are correlated with each other with the proposed model. The model with RMSEA value less than or equal to 0.06 is considered as an acceptable fit model [77].

4.5.1.4 Development of Structure Equation Modeling

In this study, there were three latent variables that include *young drivers' acceptability for distracted driving* (YDAD), *young passengers' opinions on safety of distracted driving* (YPOD), and *young drivers supporting Kansas law banning cell phone use while driving* (YDSKL). These latent variables cannot be measured directly from the survey data, so some distracted driving-related questions in the survey form were used to measure these latent variables according to their hypothesis. More specifically, *young drivers' acceptability for distracted driving* (YDAD) was measured by question 7 (i.e., Q7a, Q7b, Q7d, Q7e, Q7f, Q7g, Q7h, Q7i, Q7j, Q7k, and Q7l), *young passengers' opinions on safety of distracted driving* (YPOD) was measured by question 25 (i.e., Q25a, Q25b, Q25c, Q25d, Q25g, Q25h, Q25i, Q25j, Q25m, and Q25n), and *young drivers supporting Kansas law banning cell phone use while driving* (YDSKL) was measured by questions 36 and 37 as shown in Figure 4.7. Question 7 scale ranges from 1 "never" as minimum value to 5 "always" as maximum value as shown in Table 4.7. While, question 25 has 4-point scale ranging from 1 "very unsafe" as minimum value end to 4 "very safe" as maximum value, and questions 36 and 37 have 2-point scale ranging from 1 "no" as minimum value end to 2 "yes" as maximum value as shown in Table 4.7.

Table 4.7 Means, Standard Deviations, Variable Scale, and Cases and Missing Values of Measured Variables

Variable	Mean	S.D.	Min/Max	Cases (missing)
Young Drivers' Acceptability for Distracted Driving (YDAD)				
Q7a	4.08	0.94	1/5	451 (0)
Q7b	3.77	1.10	1/5	451 (0)
Q7d	3.14	1.11	1/5	451 (0)
Q7e	2.87	1.04	1/5	451 (0)
Q7f	2.58	1.15	1/5	440 (11)
Q7g	2.36	1.09	1/5	441 (10)
Q7h	2.33	1.11	1/5	430 (21)
Q7i	2.08	1.19	1/5	451 (0)
Q7j	2.06	1.19	1/5	449 (2)
Q7k	1.58	0.91	1/5	445 (6)
Q7l	1.22	0.65	1/5	449 (2)
Young Passengers' Opinions on Safety of Distracted Driving (YPOD)				
Q25a	3.54	0.83	1/4	407 (44)
Q25b	3.08	0.81	1/4	405 (46)
Q25c	2.65	0.92	1/4	401 (50)
Q25d	3.42	0.82	1/4	405 (46)
Q25g	1.77	0.86	1/4	406 (45)
Q25h	2.88	0.94	1/4	403 (48)
Q25i	1.78	0.86	1/4	403 (48)
Q25j	3.33	0.85	1/4	405 (46)
Q25m	1.92	0.99	1/4	403 (48)
Q25n	2.56	0.89	1/4	404 (47)
Young Drivers Supporting Kansas Law Banning Cell Phone Use While Driving (YDSKL)				
Q36	1.60	0.49	1/2	306 (145)
Q37	1.91	0.29	1/2	346 (105)

After measuring latent variables by using some distracted driving-related questions in the survey form, three major hypotheses path diagrams were used for constructing the SEM model, and the model results were discussed based on these hypotheses. The three major hypotheses among latent variables are:

- Hypothesis 1: higher passengers' opinions on distracted driving affecting traffic safety lead to higher acceptability of distracted driving (YPOD have positive effects on YDAD).

- Hypothesis 2: higher acceptability of distracted driving leads to lower supporting of Kansas laws banning cell phone use while driving (YDAD have negative effects on YDSKL).

- Hypothesis 3: higher passengers' opinions on distracted driving affecting traffic safety lead to lower supporting of Kansas laws banning cell phone use while driving (YPOD have negative effects on YDSKL).

In addition, the model examined the relationship between latent variables and socioeconomic and demographic variables. Theses socioeconomic and demographic variables include gender, age, driving frequency, education, educational messages, and crashes/ near-crashes as shown in Table 4.8.

Table 4.8 Means, Standard Deviations, Variable Scale, and Cases and Missing Values of Socioeconomic and Demographic Variables

Variable	Variable Description	Mean	S.D.	Min/ Max	Cases (missing)
Gender	[1:male, 2:female]	1.55	0.50	1/2	451 (0)
Age	[1:teenage, 2:young-adult]	1.36	0.48	1/2	451 (0)
Driving frequency	*How often do you drive a motor vehicle?* [1: never, 2: few days a year, 3: few days a month, 4: few days a week, 5: almost every day, 6: every day]	3.80	1.14	1/6	451 (0)
Education	*What is the highest level of education you have completed?* [1: some high school, 2: some college, 3: some graduate school].	1.83	0.45	1/3	451 (0)
Educational messages	*Recently, have you seen or heard educational messages that warn about the potential hazards of using a cell phone (e.g., talking or sending/reading text messages) while driving?* [1:no, 2:yes]	1.79	0.41	1/2	383 (68)
Drivers' crashes/near-crashes	*As a driver, have you been in a crash or near-crash during the last year?* [1:no, 2:yes]	1.28	0.45	1/2	385 (66)

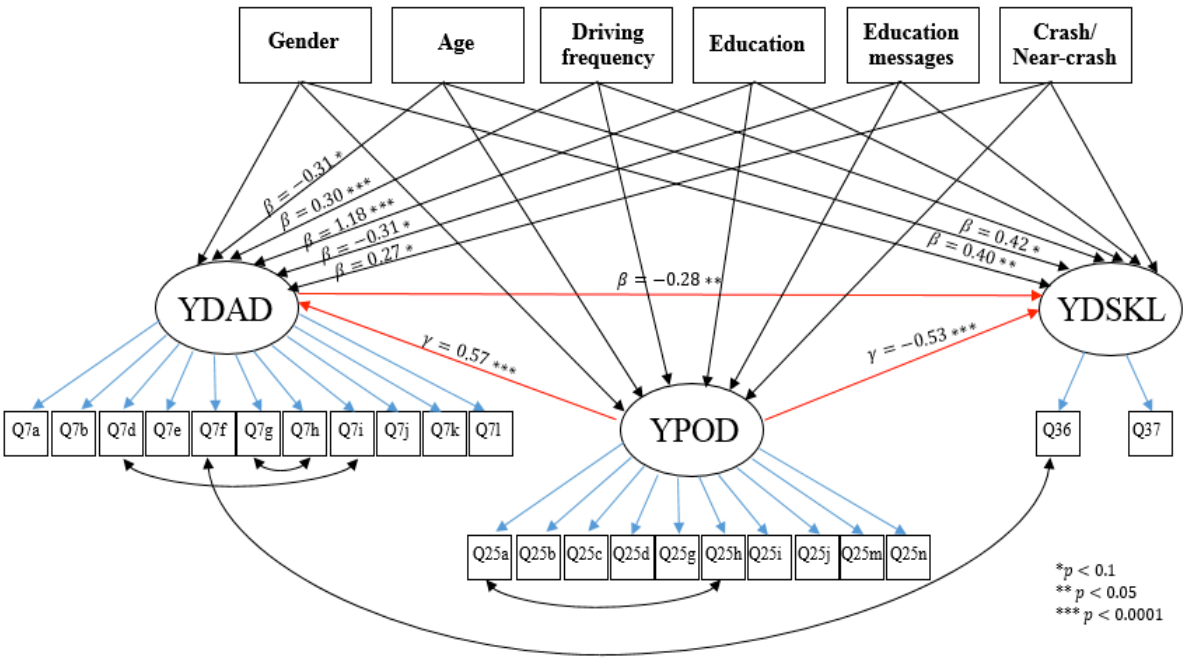


Figure 4.7 Hypothetical Path Diagram

4.5.2 Structural Equation Model Results

A structural equation model with CALIS procedure in SAS software (version 9.4) was used to establish the relationship between young drivers' characteristics such as demographic and socioeconomic status, attitudes, and behaviors associated with distracted driving and cell phone use (e.g., talking or sending/reading text messages) while driving. In this model, data from the respondents who didn't answer or didn't know the answer to the selected questions were excluded from analysis. Consequently, 234 observations of young drivers were used for structural equation model analysis.

Each hypothesis path has coefficient estimates, standard error, t-value, and p-value as shown in Tables 4.9 and 4.10. The path coefficients represented the association among measured variables and latent variables as well as the loading that contributed to construct the latent variables by measured variables. A positive path coefficient indicates that a one-unit increase in the measured variable leads to an increase in the latent variable. However, a negative path

coefficient indicates that a one-unit increase in the measured variable leads to a decrease in the latent variable. In other words, the higher path coefficients show that these measured variables had higher contribution to measure latent variables, and the opposite is true as well.

Table 4.9 Estimation Results of Hypothetical Path between Measured Variables and Latent Variables

Hypothetical Path	Coefficients Estimate	Standard Error	t-value	p-value
Young Drivers' Acceptability for Distracted Driving (YDAD)				
YDAD ⟶ Q7a	0.41	0.05	7.75	<.0001
YDAD ⟶ Q7b	0.64	0.06	11.03	<.0001
YDAD ⟶ Q7d	0.66	0.06	10.83	<.0001
YDAD ⟶ Q7e	0.65	0.06	11.83	<.0001
YDAD ⟶ Q7f	0.66	0.06	10.92	<.0001
YDAD ⟶ Q7g	0.70	0.06	12.28	<.0001
YDAD ⟶ Q7h	0.67	0.06	11.50	<.0001
YDAD ⟶ Q7i	0.27	0.07	3.85	0.0001
YDAD ⟶ Q7j	0.25	0.07	3.73	0.0002
YDAD ⟶ Q7k	0.30	0.05	6.26	<.0001
YDAD ⟶ Q7l	0.18	0.04	4.88	<.0001
Young Passengers' Opinions on Safety of Distracted Driving (YPOD)				
YPOD ⟶ Q25a	0.47	0.05	9.29	<.0001
YPOD ⟶ Q25b	0.56	0.05	11.90	<.0001
YPOD ⟶ Q25c	0.59	0.06	10.60	<.0001
YPOD ⟶ Q25d	0.52	0.05	10.72	<.0001
YPOD ⟶ Q25g	0.30	0.05	5.53	<.0001
YPOD ⟶ Q25h	0.54	0.06	8.88	<.0001
YPOD ⟶ Q25i	0.25	0.05	4.74	<.0001
YPOD ⟶ Q25j	0.48	0.05	9.67	<.0001
YPOD ⟶ Q25m	0.19	0.07	2.82	0.0049
YPOD ⟶ Q25n	0.34	0.06	6.01	<.0001
Young Drivers Supporting Kansas Law Banning Cell Phone Use While Driving (YDSKL)				
YDSKL ⟶ Q36	0.28	0.05	5.92	<.0001
YDSKL ⟶ Q37	0.13	0.02	5.95	<.0001
Coefficients between Latent Variables				
YPOD ⟶ YDAD	0.57	0.07	8.21	<.0001
YDAD ⟶ YDSKL	-0.28	0.13	-2.07	0.0385
YPOD ⟶ YDSKL	-0.53	0.13	-4.06	<.0001

The model results showed that all measured variables for *young drivers' acceptability for distracted driving* (YDAD), *young passengers' opinions on safety of distracted driving* (YPOD), and *young drivers supporting Kansas law banning cell phone use while driving* (YDSKL) are significant at a confidence level of 95% and have positive path coefficient signs.

The latent endogenous variable *young drivers' acceptability for distracted driving* (YDAD) was constructed by eleven questions as shown in Table 4.9. Positive path coefficients show positive relationships between these eleven questions and latent variable (YDAD) which indicated that the latent variable YDAD was measured following the response sequence of observed variables (from never distracted to always distracted). More specifically, the relationships among these measured variables and latent variable (YDAD) show that read messages while driving indicator widely explains *young drivers' acceptability for distracted driving* (13.0% of the total weight), while read a book or newspaper while driving indicator explains a marginal part of *young drivers' acceptability for distracted driving* latent construct (3.3%).

In the same manner, the latent exogenous variable on *young passengers' opinions on safety of distracted driving* (YPOD) was constructed by ten indicators. The relationships between latent variable YPOD and these ten indicators show that talking on a hand-held cell phone while driving indicator prevalently explains *young passengers' opinions on safety of distracted driving* latent construct (13.9% of the total weight). Furthermore, Table 4.9 shows that two measured variables were used in constructing the latent endogenous variable *young drivers supporting Kansas law banning cell phone use while driving* (YDSKL). The relationships between latent variable YDSKL and Q36 and Q37 indicate that the latent variable *young drivers supporting*

Kansas law banning cell phone use while driving is best explained by supporting Kansas law banning talking on a hand-held cell phone while driving indicator (68.3% of the total weight).

The model results showed that all hypotheses in this study were verified to be true. More specifically, the estimated path coefficients between latent variable YPOD and latent variable YDAD is positive, which shows that the first hypothesis is true: young passengers who have higher feeling of being safe when their drivers distracted while driving are more likely to drive with distractions. Furthermore, the model results showed that young drivers with higher acceptability of distracted driving lead to lower supporting the Kansas laws banning cell phone use while driving, so the second hypothesis was tested to be true with a negative path. Likewise, the negative path between latent variable YPOD and latent variable YDSKL shows that young passengers who have higher feeling of safety when their drivers distracted while driving would decrease supporting the Kansas laws banning cell phone use while driving.

Table 4.10 Estimation Results of Hypothetical Path between Latent Variables, and Socioeconomic and Demographic Variables

Hypothetical Path	Coefficients Estimate	Standard Error	t-value	p-value
Gender → YDAD	-0.09	0.15	-0.57	0.5701
Gender → YPOD	-0.11	0.15	-0.73	0.4671
Gender → YDSKL	0.40	0.20	1.99	0.0465
Age → YDAD	-0.31	0.17	-1.77	0.0773
Age → YPOD	0.09	0.17	0.54	0.5915
Age → YDSKL	0.42	0.23	1.82	0.0685
Driving frequency → YDAD	0.30	0.08	3.81	0.0001
Driving frequency → YPOD	0.01	0.07	0.11	0.9133
Driving frequency → YDSKL	0.15	0.11	1.40	0.1615
Education → YDAD	1.18	0.21	5.50	<.0001
Education → YPOD	0.31	0.19	1.61	0.1081
Education → YDSKL	0.05	0.31	0.18	0.8583
Educational messages → YDAD	-0.31	0.19	-1.64	0.0969
Educational messages → YPOD	0.26	0.19	1.38	0.1661
Educational messages → YDSKL	0.03	0.25	-0.13	0.8971
Crashes/near-crashes → YDAD	0.27	0.17	1.64	0.0968
Crashes/near-crashes → YPOD	-0.12	0.17	-0.70	0.4855
Crashes/near-crashes → YDSKL	-0.17	0.22	-0.78	0.4384

In terms of socioeconomic and demographic variables, Table 4.10 shows the relationships among individual characteristic variables that include gender, age, driving frequency, education, educational messages, and crashes/near-crashes and latent variables (YDAD, YPOD, and YDSKL). SEM analysis showed that two path coefficients were statistically significant at a confidence level of 99.99%; one path coefficients were statistically significant at a confidence level of 95%; and four path coefficients were statistically significant at a confidence level of 90%.

This SEM results indicated that female young drivers are more likely to support the Kansas laws banning cell phone use while driving than male young drivers. Furthermore, the results suggested that two age-related path coefficients were significant as an important structural factor of latent variable YDAD and latent variable YDSKL. Young-adult drivers are less prone

to distracted driving, and more likely to support the Kansas laws banning cell phone use while driving than teenage drivers.

Model results found that with an increase in driving frequency, young drivers are more likely to drive with distractions. In the same manner, with an increase in education level, young drivers are more prone to distracted driving. In addition, the model results indicated that young drivers who had seen or heard educational messages that warn about the potential hazards of using a cell phone (e.g., talking or sending/reading text messages) while driving are less probable to drive while being distracted. However, young drivers who had been in a crash or near-crash during the previous year are more probable to drive while being distracted.

Goodness of fit of the SEM was tested with SRMR, CFI, and RMSEA values. Table 4.11 shows fit summaries of SRMR = 0.08; CFI = 0.81; and RMSEA = 0.06, which reveal that, in general, the SEM fits very well and represents the culture of distracted driving in Kansas.

Table 4.11 Statistically Models Fit of SEM

Goodness-of-Fit Indices	Fit Summary
Pr > Chi-Square	<0.0001
SRMR	0.08
CFI	0.81
RMSEA	0.06

4.6 Discussion

In general, the survey results indicate that young Kansas drivers would easily accept distracted driving behaviors. In other words, a majority of young drivers would at least sometimes engage in most distraction activities while driving. In particular, a large portion of the survey participants stated that they talk to their passengers or adjust car radio while driving. Half of teenage and young-adult drivers said that they use their cell phones for talking, texting, or for

getting driving directions while driving. A large majority of these drivers reported that they continue to drive while completing conversations, and most teenage and young-adult passengers said that they felt unsafe if their drivers engaged in secondary tasks while driving. Nearly one-fourth of all young drivers' crashes and near-crashes involved cell phone-related distracted driving. It is noteworthy to mention that the majority of the survey findings agree with findings of the National Survey on Distracted Driving study [25].

According to the preliminary analysis and structural equation model (SEM) results, young drivers' characteristics affect their attitudes and behaviors associated with distracted driving and cell phone use (e.g., talking or sending/reading text messages) while driving. More specifically, preliminary analysis showed that male teenage (15–20 year old) and female young-adult (21–26 year old) drivers are more inclined to use their cell phones or talk to their passengers while driving than female teenage and male young-adult drivers. Likewise, SEM results revealed that, in general, female young (15–26 year old) drivers are more likely than male young drivers to support the Kansas laws banning cell phone use while driving. Another previous distracted-driving-related study found that male drivers were engaged in more distracted driving than female drivers [24]. Furthermore, preliminary analysis of the survey results showed that teenage passengers would feel more unsafe than young-adult passengers if their drivers were doing other activities while driving. A previous study conducted in Kansas found that young drivers were prone to use their cell phone while driving even though they believe is unsafe [78]. SEM results from this study suggested that young-adult drivers are less prone to distracted driving and are more likely to support the Kansas laws banning cell phone use while driving than teenage drivers. One possible explanation is that young-adult drivers are more aware of the hazards of distracted driving to their lives than teenage drivers. In addition, previous

studies found that driving with distractions increases as drivers' ages decrease [79, 80, 81, and 24].

The preliminary analysis showed that, in general, young drivers who drove every day or almost every day and young drivers who drove a few days a month or a few days a year are more likely to engage in cell phone use while driving than those who drove a few days a week, a result that agrees with findings of the National Survey on Distracted Driving study [25]. Also, the SEM results showed that with an increase in driving frequency, young drivers are more prone to drive with distractions. Similarly, SEM results showed that more educated young drivers are more likely to engage in distracted driving, a result that is in line with a similar Iowa study [24].

Chapter 5 – Conclusions and Recommendations

Young drivers have the highest crash risk when compared with drivers in other age groups, and distracted driving is one of the major causes of traffic crashes involving young drivers. Although the overall number of traffic crashes decreased in Kansas during the five year period between 2010 to 2014, distraction-affected crashes and crashes involving cell phone use increased during that same period. The objectives of this study was to assess the hazards of distracted driving among teenage (15–20 year old) and young-adult (21–26 year old) drivers in Kansas. This study examined five years (2011 to 2015) of crash data from the Kansas Crash and Analysis Reporting System (KCARS) database. A multinomial logit modeling was used to identify the odds that a driver with a certain type of distraction would be involved in one of the three most common crash types: rear-end, angular, and single-vehicle crashes. In addition, an ordered logistic modeling was developed to predict the likelihood of severe injury for teenage and young-adult distracted drivers and their passengers involved in crashes. This study surveyed more than 532 teenage and young-adult and survey results were analyzed with structural equation modeling (SEM).

According to analysis of crash types, young drivers were more probable to be involved in rear-end crashes when they drove in work zones. A severity model of crashes involving young-adult drivers showed that young-adult drivers who were distracted by cell phones in road construction zones and their passengers were more likely to be injured. Moreover, the survey results revealed that a large portion of young drivers reported that they use their cell phones while driving in school or work zones. Hence, a ban of cell phone use while driving in school or work zones could be considered as a possible countermeasure to reduce or avoid distracted driving and related crashes that occur in school or work zones. This type of law has already been

implemented in some states (e.g., Texas, Louisiana, and Arkansas) as partial bans for drivers of all ages [40].

Hand-held cell phone use is banned in Kansas only for drivers who are under 17 years old. However, according to the results of crash type analysis, cell phone involved crashes and cell phone use under different conditions, such as on roads with speed limit more than 60 mph or at intersections could be significant factors for increased rear-end and angular crashes. Also, cell phone use at night is a significant factor for increases in teenage drivers' single-vehicle crashes. In terms of a young-adult drivers' crash type model, most single-vehicle crashes occurred when young-adult drivers were distracted by cell phones under different conditions. In addition, given the findings of injury severity models, teenage and young-adult drivers were more likely to be severely injured in cell phone-related crashes. Survey results revealed that nearly 50% of teenage and young-adult drivers would at least sometimes use a hand-held cell phone to accept calls while driving. A previous study indicated that hand-held cell phone bans that applied to all drivers contributed to decreases in fatal crashes involving teenage (20 years old and younger) drivers, while hand-held cell phone bans that only applied to teenage drivers had no significant effect in reducing teenage fatal crashes [48]. Consequently, implementation of hand-held cell phone bans for all drivers would be beneficial for reducing distraction-affected crashes, particularly for teenage and young-adult drivers. Further, improving young drivers' education will help to understand how cell phone use while driving influences their driving risk. Accordingly, the findings of this study should be shared with the Kansas Department of Revenue and with Kansas education officials to guide the design of driver education courses at professional driving schools and at Kansas high schools to emphasize the hazards of using cell

phones while driving to the lives of teenage and young-adult Kansas drivers and their passengers as well as other road users.

In addition, an investigation that compared young drivers crashes involving cell phone use in Manhattan, Kansas, a city with bans on hand-held cell phone and in Lawrence, Kansas, a city without hand-held cell phone use bans was conducted to identify the effectiveness of hand-held cell phone use bans in reducing young drivers crashes involving cell phone use. The results of this investigation showed that bans on hand-held cell phone for drivers of all ages in Manhattan, Kansas, helped to reduce young drivers' crashes involving cell phone use. This investigation is helpful in developing convincing arguments to support the proposed Kansas state-wide hand-held cell phone ban law.

A majority of teenagers and young-adults reported that they never used their cell phones while driving when they saw police officers. As a result, good laws coupled with highly visible police presence and enforcement could help to reduce the use of hand-held cell phones while driving. Other studies have shown that high-visibility police enforcement helped to reduce hand-held cell phone use while driving in Connecticut, New York, California, and Delaware [37 and 38].

The effectiveness of the Kansas Graduated Driver Licensing (GDL) system in reducing teenage drivers' distraction-affected crashes was also investigated in the current study. The Kansas GDL system prohibits driving with front-seat passengers only for drivers who under 17 years old. However, preliminary analysis of crash data for all teenage drivers showed that a large majority of their front-seat passengers were teenagers. Additionally, about 17% of total teenage drivers' distraction-affected crashes occurred when teenage front-seat passengers were present at the time of the crash. These facts are also supported by crash-type model results for teenage

drivers: the presence of teenage front-seat passengers was a significant factor in teenage drivers' model, although teenage front-seat passengers was not significant in the young-adult drivers model. In particular, if these teenage drivers drove with their peers as front-seat passengers and were distracted by other electronic devices or inside the vehicle, they were more probable to be involved in single-vehicle crashes or angular collisions.

The results of the teenage drivers injury severity model showed that when teenage drivers drove with front-seat passengers and were distracted by secondary tasks at the time of a crash, they and their front-seat passengers were more probable to be injured. The survey results revealed that a large portion of teenage drivers stated that they talk to their passengers while operating vehicles, which means that teenage front-seat passengers contribute to increased teenage driver crashes. As a result, additional GDL passenger restrictions for all teenage drivers (15–20 year old) could help improve the safety of teenage drivers and their passengers. Moreover, several studies found a teenage passenger restriction contribute to decrease teenage drivers' distraction-affected crashes [42, 43, 44, 45, and 46].

According to the crash data models developed in this study, curved roads, intersections, off roadway crashes, rural roads, multi-lanes roads, poor road surface conditions, roads with speed limits >60 mph, and nighttime are significant factors for increased teenage and young-adult drivers distraction-affected crashes. Hence, roadway countermeasures such as centerline and shoulder rumble strips are needed in curved, rural, and multi lanes roadways to alert distracted drivers and help prevent distraction-affected crashes when drivers leave their travel lanes. Further, these findings suggest incorporating or continuing to incorporate verbal messages that encourage drivers not to become distracted while driving, particularly on rural or curved roads. Also other roadway countermeasures, such as wide and visible edge lines, more highly

visible road signs, and better lighting at night, have demonstrated their effectiveness in reducing distraction-affected crashes [36].

The Kansas crash database does not provide more specific details related to cell phone distraction, such as making/receiving phone calls or sending/reading text messages. The Kansas crash database also does not record passengers who are present at the time of a crash as a contributing factor in the distraction types. Therefore, The Kansas crash data collection should be improved to provide detailed distraction type categories like other states crash data collection efforts where such data are collected.

Crash data coupled with survey data have not been previously used to investigate the current distracted driving culture in Kansas. Nationally, few research efforts using crash databases have been completed that identify major factors that contribute to increases in the likelihood of occurrences of distracted driving crashes involving teenage and young-adult drivers. In addition, only limited studies exist to evaluate driver attitudes and behaviors associated with distracted driving and cell phone use in teenage novice (15–17 year old) drivers. The results of this study can be used to develop comprehensive state-wide intervention approaches to deter distracted driving and improve teenage and young-adult safety culture in the future.

5.1 Study Limitations

This study has five limitations. The first two limitations of this study relate to the Kansas crash data, and the other three limitations relate to the survey data. As mentioned earlier, the Kansas crash database does not provide more details related to cell phone distraction (e.g., whether making/receiving phone call or sending/reading text messages) and does not record passengers who are present at the time of the crash as a contributing factor in the distraction

types. In addition, although crash databases are controversial due to challenges in knowing the precise contributory causes of crashes and how information about driver distractions are reported, these databases do suggest that teenage and young-adult drivers' distraction-affected crashes may account for a very small percentage of total crashes.

To address these crash database limitations, young drivers were surveyed to understand the culture of distracted driving in more detail. In terms of the limitations related to the survey data, surveys were only collected from students at Manhattan High School, a sample that may not represent all Kansas high school students. Furthermore, many young participants in this study may have wished to minimize the fact that they engage in distraction activities. As a result, the survey results may not accurately represent young drivers' attitudes and behaviors associated with distracted driving and cell phone use while driving, since these were voluntary responses. Another limitation involves the structural equation model (SEM) where responses with missing values were excluded from analysis. Consequently, to achieve an acceptable SEM with good fit, only one model was developed for both teenage (15–20 year old) and young-adult (21–26 year old) drivers so the total dataset contained 234 observations of young drivers that were used for SEM analysis.

References

[1] NHTSA. 2016. Traffic Safety Fact 2014. National Highway Traffic Safety Administration, Washington, D.C. https://crashstats.nhtsa.dot.gov/Api/Public/Publication/812261 Accessed on August 25, 2016.

[2] U.S. Department of Transportation (USDOT), Federal Highway Administration. 2018. Highway Statistics https://www.fhwa.dot.gov/policyinformation/statistics.cfm Accessed on March 10, 2018.

[3] KDOT. 2017. 2016 Kansas Traffic Accident Facts. Kansas Department of Transportation. Topeka, KS. https://www.ksdot.org/Assets/wwwksdotorg/bureaus/burTransPlan/prodinfo/accstat/2016FactsBook.pdf Accessed on March 10, 2018.

[4] Sheridan, T. B. 2004. Driver distraction from a control theory perspective. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *46*(4), 587-599.

[5] Donmez, B., Boyle, L. N., & Lee, J. D. 2006. The impact of distraction mitigation strategies on driving performance. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *48*(4), 785-804.

[6] Pettitt, M., Burnett, G. E., & Stevens, A. 2005. Defining driver distraction. In *12th World Congress on Intelligent Transport Systems*.

[7] Regan, M. A., Hallett, C., & Gordon, C. P. 2011. Driver distraction and driver inattention: Definition, relationship and taxonomy. *Accident Analysis & Prevention*, *43*(5), 1771-1781.

[8] National Highway Traffic Safety Administration. 2012. Visual-manual NHTSA driver distraction guidelines for in-vehicle electronic devices. *Washington, DC: National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT)*.

[9] De Winter, J. C. F., & Dodou, D. 2010. The Driver Behaviour Questionnaire as a predictor of accidents: A meta-analysis. *Journal of safety research*, *41*(6), 463-470.

[10] NHTSA. 2016. Traffic Safety Fact: Distracted Driving 2014. National Highway Traffic Safety Administration, Washington, D.C. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812260 Accessed on September 21, 2016.

[11] AAA Foundation for Traffic Safety. 2013. 2012 Traffic Safety Culture Index. Washington, DC. https://www.aaafoundation.org/sites/default/files/2012TrafficSafetyCultureIndex.pdf Accessed on November 14, 2016.

[12] KDOT. 2017. 2016 Kansas Traffic Accident Facts: Driver Distractions. Kansas Department of Transportation. Topeka, KS.

https://www.ksdot.org/Assets/wwwksdotorg/bureaus/burTransPlan/prodinfo/2016factsbook/Distractions.pdf Accessed on March 3, 2018.

[13] Braitman, K. A., Kirley, B. B., McCartt, A. T., & Chaudhary, N. K. 2008. Crashes of novice teenage drivers: Characteristics and contributing factors. *Journal of safety research*, *39*(1), 47-54.

[14] Dissanayake, S., & Asmarasingha, N. 2013. *Improving Safety of Teenage and Young Adult Drivers in Kansas* (No. K-TRAN: KSU-10-6). Kansas Department of Transportation.

[15] Bernard, J. M., & Sweeney II, D. C. 2015. Contributing Circumstances Impact on Missouri Teenage Driver Crash Fatalities. In *Journal of the Transportation Research Forum* (Vol. 54, No. 1, pp. 5-21).

[16] Ehsani, J. P., Bingham, C. R., Shope, J. T., Sunbury, T. M., & Kweon, B. 2010. Teen driving exposure in Michigan: Demographic and behavioral characteristics. *Accident Analysis & Prevention*, *42*(4), 1386-1391.

[17] Ghazizadeh, M., & Boyle, L. 2009. Influence of driver distractions on the likelihood of rear-end, angular, and single-vehicle crashes in Missouri. *Transportation Research Record: Journal of the Transportation Research Board*, (2138), 1-5.

[18] Neyens, D. M., & Boyle, L. N. 2007. The effect of distractions on the crash types of teenage drivers. *Accident Analysis & Prevention*, *39*(1), 206-212.

[19] Neyens, D. M., & Boyle, L. N. 2008. The influence of driver distraction on the severity of injuries sustained by teenage drivers and their passengers. *Accident Analysis & Prevention*, *40*(1), 254-259.

[20] Zishu, L. 2012. *The Effects of Distractions and Driver's Age on the Type of Crash and the Injury Severity Sustained by Occupants Involved in a Crash* (Doctoral dissertation).

[21] Lam, L. T. 2002. Distractions and the risk of car crash injury: the effect of drivers' age. *Journal of safety research*, *33*(3), 411-419.

[22] Tung, L. W. C. 2014. *The investigation of distracted driving at highway-rail grade crossings* (Doctoral dissertation, THE UNIVERSITY OF NEBRASKA-LINCOLN).

[23] Pigman, J. G., Agent, K. R., & Green, E. R. 2010. Distracted Driving–Preliminary Analysis and Survey.

[24] Li, W., Gkritza, K., & Albrecht, C. 2014. The culture of distracted driving: evidence from a public opinion survey in Iowa. *Transportation research part F: traffic psychology and behaviour*, *26*, 337-347.

[25] Schroeder, P., Meyers, M., & Kostyniuk, L. 2013. *National survey on distracted driving attitudes and behaviors--2012* (No. DOT HS 811 729).

[26] McEvoy, S. P., Stevenson, M. R., & Woodward, M. 2006. The impact of driver distraction on road safety: results from a representative survey in two Australian states. *Injury prevention*, *12*(4), 242-247.

[27] Harrison, M. A. 2011. College students' prevalence and perceptions of text messaging while driving. *Accident Analysis & Prevention*, *43*(4), 1516-1520.

[28] Brusque, C., & Alauzet, A. 2008. Analysis of the individual factors affecting mobile phone use while driving in France: Socio-demographic characteristics, car and phone use in professional and private contexts. *Accident Analysis & Prevention*, *40*(1), 35-44.

[29] Stavrinos, D., Jones, J. L., Garner, A. A., Griffin, R., Franklin, C. A., Ball, D., ... & Fine, P. R. 2013. Impact of distracted driving on safety and traffic flow. *Accident Analysis & Prevention*, *61*, 63-70.

[30] NHTSA. 2012. 2010 Traffic Safety Fact: Overview. National Highway Traffic Safety Administration, Washington, D.C. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811552 Accessed on February 16, 2016.

[31] McCartt, A. T., Hellinga, L. A., & Bratiman, K. A. 2006. Cell phones and driving: review of research. *Traffic injury prevention*, *7*(2), 89-106.

[32] McCartt, A. T., Hellinga, L. A., Strouse, L. M., & Farmer, C. M. 2010. Long-term effects of handheld cell phone laws on driver handheld cell phone use. *Traffic injury prevention*, *11*(2), 133-141.

[33] Nikolaev, A. G., Robbins, M. J., & Jacobson, S. H. 2010. Evaluating the impact of legislation prohibiting hand-held cell phone use while driving. *Transportation research part A: policy and practice*, *44*(3), 182-193.

[34] Ehsani, J. P., Bingham, C. R., Ionides, E., & Childers, D. 2014. The impact of Michigan's text messaging restriction on motor vehicle crashes. *Journal of Adolescent Health*, *54*(5), S68-S74.

[35] Highway Loss Data Institute. 2009. Hand-held cellphone laws and collision claim frequencies. www.iihs.org/media/1afa0aef-990d-4888-9039.../ue4d5w/.../hldi_bulletin_26.17.pdf Accessed on March 16, 2016.

[36] Goodwin, A., Thomas, L., Kirley, B., Hall, W., O'Brien, N., & Hill, K. 2015. *Countermeasures that work: A highway safety countermeasure guide for State highway safety offices, Eighth edition,* Report No. DOT HS 812 202. Washington, DC: National Highway Traffic Safety Administration.

[37] Cosgrove, L., Chaudhary, N., & Reagan, I. 2011. *Four high-visibility enforcement demonstration waves in Connecticut and New York reduce hand-held phone use* (No. HS-811 845).

[38] Schick, A., Vegega, M., & Chaudhary, N. 2014. *Distracted Driving High-Visibility Enforcement Demonstrations in California and Delaware* (No. DOT HS 811 993).

[39] Guarino, J. 2013. Survey Reveals Public Open to Ban on Hand-Held Cell Phone Use and Texting. *Bureau of Transportation Statistics (BTS), Washington DC*.

[40] IIHS. 2017. Distracted driving: State laws. Insurance Institute for Highway Safety. www.iihs.org/iihs/topics/laws/cellphonelaws?topicName=distracted-driving Accessed on March 27, 2017.

[41] AAA Digest of Motor Laws. 2017. Distracted Driving. Washington, DC. http://drivinglaws.aaa.com/tag/distracted-driving Accessed on April 10, 2017.

[42] Fell, J. C., Jones, K., Romano, E., & Voas, R. 2011. An evaluation of graduated driver licensing effects on fatal crash involvements of young drivers in the United States. *Traffic injury prevention*, *12*(5), 423-431.

[43] Lyon, J. D., Pan, R., & Li, J. 2012. National evaluation of the effect of graduated driver licensing laws on teenager fatality and injury crashes. *Journal of safety research*, *43*(1), 29-37.

[44] Masten, S. V., Foss, R. D., & Marshall, S. W. 2013. Graduated driver licensing program component calibrations and their association with fatal crash involvement. *Accident Analysis & Prevention*, *57*, 105-113.

[45] McCartt, A. T., Teoh, E. R., Fields, M., Braitman, K. A., & Hellinga, L. A. 2010. Graduated licensing laws and fatal crashes of teenage drivers: a national study. *Traffic injury prevention*, *11*(3), 240-248.

[46] Williams, A. F. 2007. Contribution of the components of graduated licensing to crash reductions. *Journal of Safety Research*, *38*(2), 177-184.

[47] Goodwin, A. H., O'Brien, N. P., & Foss, R. D. 2012. Effect of North Carolina's restriction on teenage driver cell phone use two years after implementation. *Accident Analysis & Prevention*, *48*, 363-367.

[48] Ehsani, J. P., Bingham, C. R., Ionides, E., & Childers, D. 2014. The impact of Michigan's text messaging restriction on motor vehicle crashes. *Journal of Adolescent Health*, *54*(5), S68-S74.

[49] Lim, S. H., & Chi, J. 2013. Are cell phone laws in the US effective in reducing fatal crashes involving young drivers?. *Transport policy*, *27*, 158-163.

[50] IIHS. 2012. they're working: Insurance collision claims data show which new technologies are preventing crashes, Report No. 47. Insurance Institute for Highway Safety. http://www.iihs.org/iihs/sr/statusreport/article/47/5/1 Accessed on March 4, 2017.

[51] Yager, C. 2013. *An evaluation of the effectiveness of voice-to-text programs at reducing incidences of distracted driving* (No. SWUTC/13/600451-00011-1).

[52] GHSA. 2011. Distracted Driving, what research shows and what states can do. Governors Highway safety Association, Washington, DC. http://ghsa.madwolf.com/html/publications/sfdist.html Accessed on November 8, 2016.

[53] Funkhouser, D., & Sayer, J. R. 2013. Cell phone filter/blocker technology field test, Report No. DOT HS 811 863. Washington, DC: National Highway Traffic Safety Administration.

[54] KDOT. 2014. Motor Vehicle Accident Report Coping Manual. Kansas Department of Transportation. Topeka, KS.

[55] Allison, P. D. 2012. *Logistic regression using SAS: Theory and application*. SAS Institute.

[56] Xeudong, Y., Radwan, E., Mannila, K. K., & Richards, S. 2009. Investigation of truck-involved angle crashes based on GES and FARS crash databases.

[57] Mendenhall, W., Sincich, T., & Boudreau, N. S. 1996. *A second course in statistics: regression analysis* (Vol. 5). Upper Saddle River^ eNew Jersey New Jersey: Prentice Hall.

[58] Mela, C. F., & Kopalle, P. K. 2002. The impact of collinearity on regression analysis: the asymmetric effect of negative and positive correlations. *Applied Economics*, *34*(6), 667-677.

[59] Swinscow, T. D. V., & Campbell, M. J. 2002. Statistics at square one. *Statistics at square one.*, (Ed. 10).

[60] Kansas State Legislature, Senate Transportation Committee, http://www.kslegislature.org/li/b2017_18/committees/ctte_s_trnsprt_1/documents/?date_choice=2017-02-08 Accessed on April 18, 2017.

[61] City of Manhattan, Mobile Device Use in Manhattan, http://cityofmhk.com/1563/Mobile-Device-Use-in-Manhattan Accessed on April 15, 2017.

[62] City of Junction City, Listening or Talking on Wireless Communication Devices While Driving Enforcement http://www.junctioncity-ks.gov/newsView.aspx?nid=284&id=1511&catid=1 Accessed on April 15, 2017.

[63] Wilson, J., Fang, M., Wiggins, S., & Cooper, P. 2003. Collision and violation involvement of drivers who use cellular telephones. *Traffic injury prevention*, *4*(1), 45-52.

[64] U.S. Department of Transportation (USDOT), Federal Highway Administration. *Highway Statistics 2014* http://www.fhwa.dot.gov/policyinformation/statistics/2014 Accessed on November 03, 2017.

[65] Hancock, P. A., Lesch, M., & Simmons, L. 2003. The distraction effects of phone use during a crucial driving maneuver. *Accident Analysis & Prevention*, *35*(4), 501-514.

[66] Horrey, W. J., & Wickens, C. D. 2006. Examining the impact of cell phone conversations on driving using meta-analytic techniques. *Human factors*, *48*(1), 196-205.

[67] Li, Q. 2013. A novel Likert scale based on fuzzy sets theory. *Expert Systems with Applications*, *40*(5), 1609-1618.

[68] Lei, P. W., & Wu, Q. 2007. Introduction to structural equation modeling: Issues and practical considerations. *Educational Measurement: issues and practice*, *26*(3), 33-43.

[69] Tabachnick, B. G., & Fidell, L. S. 1996. Using Multivariate Statistics, New York: HarperCollins College Publishers.

[70] Nelson, E., Atchley, P., & Little, T. D. 2009. The effects of perception of risk and importance of answering and initiating a cellular phone call while driving. *Accident Analysis & Prevention*, *41*(3), 438-444.

[71] Golob, T. E., & Hensher, D. A. 1996. Driving behaviour of long distance truck drivers: the effects of schedule compliance on drug use and speeding citations. *International Journal of Transport Economics/Rivista internazionale di economia dei trasporti*, 267-301.

[72] Silva, J. D. A., Morency, C., & Goulias, K. G. 2012. Using structural equations modeling to unravel the influence of land use patterns on travel behavior of workers in Montreal. *Transportation Research Part A: Policy and Practice*, *46*(8), 1252-1264.

[73] Bentler, P. M., & Weeks, D. G. 1980. Linear structural equations with latent variables. *Psychometrika*, *45*(3), 289-308.

[74] Washington, S. P., Karlaftis, M. G., & Mannering, F. L. 2003. Statistical and econometric methods for transportation data analysis. *Chapman Hall/CRC, Boca Raton, FL*.

[75] Markus, K. A. 2012. Principles and practice of structural equation modeling by Rex B. Kline.

[76] Bender, P. 1995. EQS Structural Equations Program Manual (Multivariate Software, Encino, CA).

[77] Hu, L. T., & Bentler, P. M. 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1-55.

[78] Nelson, E., Atchley, P., & Little, T. D. 2009. The effects of perception of risk and importance of answering and initiating a cellular phone call while driving. *Accident Analysis & Prevention*, *41*(3), 438-444.

[79] Goodwin, A. H., Foss, R. D., Harrell, S. S., & O'Brien, N. P. 2012. Distracted driving among newly licensed teen drivers.

[80] Hosking, S. G., Young, K. L., & Regan, M. A. 2009. The effects of text messaging on young drivers. *Human factors*, *51*(4), 582-592.

[81] Donovan, J. E. 1993. Young adult drinking-driving: behavioral and psychosocial correlates. *Journal of studies on alcohol*, *54*(5), 600-613.

Appendix A – Correlation Matrix for Measured Variables

Table A.1 Correlation Matrix for Crash Type Model of Teenage Drivers

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.Cell phone	1	-0.03063	-0.06744	-0.03465	-0.35156	-0.00377	-0.00024	0.06064	0.01495	0.019	-0.00606	-0.01266	0.00675	-0.01497
2.Other electronic devices	-0.03063	1	-0.0512	-0.0263	-0.26689	0.0132	-0.00585	-0.00147	-0.00245	0.014	0.00338	-0.01128	0.00389	0.00078
3.In/on vehicle distraction	-0.06744	-0.0512	1	-0.05791	-0.5876	0.01218	-0.00731	-0.02135	0.00687	0.01	-0.01651	0.00635	0.00687	0.00532
4.External distraction	-0.03465	-0.0263	-0.05791	1	-0.30188	0.0094	0.01802	-0.01571	-0.00914	-0.01	-0.001	0.00968	0.00319	-0.00513
5.Inattention	-0.35156	-0.26689	-0.5876	-0.30188	1	-0.01492	0.00055	-0.05354	-0.01425	-0.02	0.01516	0.00151	0.00004	-0.00008
6.Valid licensed	-0.00377	0.0132	0.01218	0.0094	-0.01492	1	0.10819	-0.04814	0.02151	0.021	-0.00357	-0.01936	-0.00333	-0.01244
7.Restricted license	-0.00024	-0.00585	-0.00731	0.01802	0.00055	0.10819	1	-0.02086	0.00882	-0.01	0.00282	0.00087	0.0029	0.01686
8.Alcohol/drug related	0.06064	-0.00147	-0.02135	-0.01571	-0.05354	-0.04814	-0.02086	1	0.00625	0.006	0.00274	-0.01131	-0.00921	-0.00961
9.Vehicle age (Year 5 or newer)	0.01495	-0.00245	0.00687	-0.00914	-0.01425	0.02151	0.00882	0.00625	1	-0.08	-0.13271	-0.18452	0.05045	-0.01211
10.Vehicle age (6-10 years)	0.01917	0.01421	0.00988	-0.00611	-0.01793	0.02121	-0.00712	0.00617	-0.0775	1	-0.28797	-0.4004	0.03259	-0.01599
11.Vehicle age (11-15 years)	-0.00606	0.00338	-0.01651	-0.001	0.01516	-0.00357	0.00282	0.00274	-0.13271	-0.29	1	-0.68568	-0.01689	0.02801
12.Vehicle age (Year 16 or older)	-0.01266	-0.01128	0.00635	0.00968	0.00151	-0.01936	0.00087	-0.01131	-0.18452	-0.4	-0.68568	1	-0.02481	-0.01061
13.Automobile	0.00675	0.00389	0.00687	0.00319	0.00004	-0.00333	0.0029	-0.00921	0.05045	0.033	-0.01689	-0.02481	1	-0.22364
14.Van	-0.01497	0.00078	0.00532	-0.00513	-0.00008	-0.01244	0.01686	-0.00961	-0.01211	-0.02	0.02801	-0.01061	-0.22364	1
15.Pickup truck camper-rv	0.00426	-0.02144	-0.01313	0.01246	-0.00594	0.01906	-0.00943	0.01705	-0.04945	-0.06	-0.05394	0.11445	-0.60506	-0.0678
16.Sport utility vehicle	-0.00752	0.01624	0.00225	-0.0143	0.00583	-0.0089	-0.00143	-0.00082	-0.01096	0.029	0.06443	-0.07802	-0.60274	-0.06754
17.Straight following	0.03591	0.04121	0.06757	0.00906	-0.12704	0.02134	0.00007	0.00875	-0.01595	0.013	-0.00211	-0.00047	0.00705	0.00068
18.Turn/changing lanes maneuver	-0.032	-0.04153	-0.07116	0.00769	0.11785	-0.01673	0.01296	-0.02366	0.01927	-0.02	0.00539	-0.00094	-0.00334	-0.00354
19.Avoiding maneuver	-0.00557	0.00162	0.00155	0.00214	0.00426	-0.00443	-0.01489	0.02213	0.00305	0.004	-0.00622	0.00296	-0.00878	-0.00332
20.Stopped/parking/backing maneuver	-0.0276	-0.0217	-0.01364	-0.02179	0.0679	0.0019	-0.00855	-0.01636	0.00441	0.006	0.00315	-0.00798	-0.00684	0.00485
21.No damage	-0.01704	-0.00948	0.01021	0.00582	0.01338	0.00837	-0.00001	-0.008	-0.00846	-0.02	-0.01731	0.03015	-0.04779	0.00968
22.Minor damage	-0.02776	-0.01872	-0.02754	-0.00083	0.08666	0.01708	-0.01801	-0.05008	0.00591	3E-04	-0.02389	0.02007	-0.10261	-0.01045
23.Functional damage	-0.01784	-0.01454	-0.03481	0.01709	0.07779	-0.00327	0.01147	-0.06543	-0.00396	0.007	0.00633	-0.00839	0.02565	-0.00039
24.Disabling damage	0.02678	0.03061	0.03308	-0.00593	-0.08201	0.00164	0.00383	0.03748	0.00707	0.011	0.01513	-0.0251	0.07941	0.01223
25.Destroyed damage	0.02746	0.00594	0.03804	-0.01657	-0.12569	-0.0247	-0.00019	0.12709	-0.00901	-0.02	0.01034	0.01034	-0.00762	-0.00978
26.Driver with passengers	-0.0538	-0.01785	0.0273	-0.0061	0.04671	-0.06838	-0.01375	0.01915	-0.01517	-0.02	0.00288	0.01503	-0.00939	0.03698
27.Female driver	-0.00302	-0.00299	0.02921	-0.00001	0.03206	0.0288	0.05623	-0.06049	0.03371	0.065	0.03733	-0.0944	0.14468	0.00071
28.Driver safety belt used	-0.04382	0.00527	0.00192	0.01807	0.02581	0.08491	0.02982	-0.1459	0.01714	0.017	0.00868	-0.0218	0.01817	0.01729
29.Ejected	-0.00769	-0.01011	-0.00785	-0.01143	0.00508	-0.01755	-0.00314	0.0367	-0.00657	-0.01	0.01352	-0.00602	-0.0153	0.00358
30.Trapped	0.03133	-0.00451	0.00819	-0.0067	-0.04534	-0.00457	-0.00571	0.07349	0.00242	-0	0.00537	-0.00418	-0.01737	-0.00517
31.Fatal injury/injury incapacitating	0.02232	-0.01001	0.01351	-0.00811	-0.03985	-0.0187	-0.01236	0.11669	-0.00237	-0	0.01266	-0.00873	-0.00408	0.00358
32.Injury not incapacitating /possible injury	0.01117	0.01616	0.02675	-0.01507	-0.09503	-0.02266	-0.00729	0.09419	-0.01835	-0.01	-0.00152	0.01122	0.01809	-0.01523
33.Not injured	-0.0189	-0.0099	-0.02568	0.01484	0.0996	0.03451	0.01395	-0.12028	0.01839	0.006	0.00441	-0.01226	-0.01827	0.0122
34.Teen passengers	-0.04332	-0.01339	0.01901	-0.00523	0.03936	-0.02491	-0.01198	0.02229	-0.01102	-0.01	-0.00724	0.02124	0.01503	-0.00788
35.Speed limit<35 mph	-0.01016	-0.03318	-0.01226	-0.02891	0.08542	-0.0605	-0.03348	0.00176	0.00449	-0.02	-0.01374	0.02204	-0.01083	0.00456
36.Speed limit_35-60 mph	0.0081	0.01794	0.0128	0.04913	-0.00901	0.04931	0.03202	-0.01194	-0.0102	0.016	-0.01036	0.0025	0.00693	-0.01027
37.Speed limit>60 mph	0.00196	0.01778	-0.00168	-0.03633	-0.11715	0.01736	0.0012	0.0195	0.00473	-0	0.03782	-0.03565	0.0047	0.01189
38.Concrete road surface type	-0.01231	-0.00615	-0.01129	0.03135	0.00435	-0.01369	0.00706	-0.00022	-0.00145	-0.01	0.00772	0.00224	0.02979	-0.00687
39.Black top road surface	0.01064	0.00989	0.00301	-0.01964	-0.00195	0.02502	-0.01313	-0.0286	0.00966	0.015	-0.00068	-0.01398	0.00946	0.00665
40.Gravel/brick road surface type	0.00187	-0.00727	0.0163	-0.01892	-0.0038	-0.02598	0.01513	0.06074	-0.01562	-0.01	-0.01411	0.0234	-0.07701	-0.00541
41.Wet/debris road surface condition	-0.00414	-0.01703	-0.04193	-0.01398	0.05489	-0.0061	-0.00474	0.00079	-0.01055	-0.02	0.00553	0.01389	-0.00991	0.00145
42.Curved road	0.01853	0.00212	0.00886	-0.02165	-0.04464	-0.01694	-0.00901	0.03101	0.02293	0.012	-0.01506	-0.00227	0.00626	-0.00649
43.Work_zone_realeted	-0.00797	0.00824	-0.00671	-0.00669	0.01088	0.0041	0.00047	-0.00047	0.00267	0.011	0.00659	-0.01475	0.01107	0.00325
44.Multi lanes road	-0.00874	0.00116	0.01265	0.01262	-0.01489	-0.00018	0.00165	-0.00481	0.00403	0.008	-0.00291	-0.00481	0.00494	-0.01244
45.5.00-9.00-Morning	-0.02043	-0.01606	-0.01288	-0.02303	-0.02388	0.01396	0.03815	-0.00998	0.00148	-0.01	0.00336	0.00492	-0.00952	0.00669
46.9.00-13.00-Noon	-0.01775	0.0005	0.00415	-0.00562	0.03836	-0.01257	-0.00573	-0.04779	-0.00827	0.014	0.00304	-0.0092	-0.01483	0.01548
47.13.00-17.00-Afternoon	-0.02731	-0.00378	-0.00258	0.00999	0.06696	0.0238	-0.00673	-0.08606	-0.00452	-0.01	-0.00982	0.01592	0.0023	-0.00478
48.17.00-21.00-Evening	0.01074	0.00878	0.01568	0.02484	0.01308	0.02145	-0.00437	-0.02798	-0.00157	0.004	0.00744	-0.0088	0.01645	0.00012
49.21.00-5.00-Night	0.06872	0.0102	-0.00718	-0.01499	-0.13364	-0.06091	-0.01805	0.22727	0.01781	0.002	-0.00252	-0.00645	0.00523	-0.0173
50.Week end	0.02141	0.02114	0.01486	-0.00178	-0.10692	-0.02974	-0.01954	0.11253	0.00674	0.003	-0.0012	-0.00271	-0.00952	-0.00905
51.On roadway	-0.02332	0.0008	-0.02725	0.01021	0.05178	0.01028	-0.01257	-0.03448	-0.0139	-0.02	-0.0075	0.02384	0.01628	-0.01891
52.At Intersection	-0.01979	-0.02223	-0.02736	0.02391	0.1227	0.01326	0.00906	-0.07092	-0.00469	0.011	0.00614	-0.01273	0.0021	0.01265
53.Off roadway crash	0.05899	0.02932	0.07146	-0.04649	-0.23468	-0.02775	0.00418	0.13687	0.02575	0.007	0.0018	-0.0142	-0.02384	0.00555
54.Dark	0.06517	0.00255	-0.00585	-0.01477	-0.11079	-0.02958	-0.00892	0.18262	0.01269	0.007	0.00887	-0.01766	0.01438	-0.01355
55.Adverse weather conditions	0.00447	-0.01665	-0.03435	-0.01362	0.04288	0.00103	0.0001	0.00013	-0.00905	-0.02	0.00609	0.01092	-0.00107	0.00089
56.Rural roads	0.01166	0.00483	0.0418	-0.0504	-0.11112	0.03343	0.01657	0.06763	-0.01205	-0.01	-0.00386	0.01481	-0.07352	-0.00224
57.Animal factors	-0.02588	-0.01057	-0.01191	0.01064	0.02442	0.00397	0.01185	-0.00174	-0.01066	0.004	0.00506	-0.00351	-0.00391	0.01286
58.Weather factors	-0.01488	-0.00399	-0.01623	-0.00701	0.03043	-0.0031	-0.00268	-0.00259	-0.00509	-0.02	0.00607	0.00994	0.00771	-0.0049
59.Vision obstruction factors	0.01073	-0.00606	0.00462	0.00393	-0.00665	0.00323	0.00625	-0.00572	-0.00751	-0.01	-0.00102	0.01179	-0.01401	0.00541
60.Vehicle factors	-0.00719	-0.01243	0.01374	-0.01405	0.01366	0.0037	-0.00001	-0.00544	-0.00569	-0.03	-0.01014	0.03207	0.00696	-0.00716
61.Road factors	-0.02432	-0.00047	-0.00623	-0.00282	0.02263	0.02712	-0.00272	0.00005	-0.00419	-0.02	0.01694	-0.00321	-0.00146	0.00496

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.1 (continued)

Variable	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1.Cell phone	0.00426	-0.00752	0.03591	-0.032	-0.00557	-0.0276	-0.01704	-0.02776	-0.01784	0.027	0.02746	-0.0538	-0.00302	-0.04382	-0.00769
2.Other electronic devices	-0.02144	0.01624	0.04121	-0.04153	0.00162	-0.0217	-0.00948	-0.01872	-0.01454	0.031	0.00594	-0.01785	-0.00299	0.00527	-0.01011
3.In/on vehicle distraction	-0.01313	0.00225	0.06757	-0.07116	0.00155	-0.01364	0.01021	-0.02754	-0.03481	0.033	0.03804	0.0273	0.02921	0.00192	-0.00785
4.External distraction	0.01246	-0.0143	0.00906	0.00769	0.00214	-0.02179	0.00582	-0.00083	0.01709	-0.01	-0.01657	-0.0061	-0.00001	0.01807	-0.01143
5.Inattention	-0.00594	0.00583	-0.12704	0.11785	0.00426	0.0679	0.01338	0.08666	0.07779	-0.08	-0.12569	0.04671	0.03206	0.02581	0.00508
6.Valid licensed	0.01906	-0.0089	0.02134	-0.01673	-0.00443	0.0019	0.00837	0.01708	-0.00327	0.002	-0.0247	-0.06838	0.0288	0.08491	-0.01755
7.Restricted license	-0.00943	-0.00143	0.00007	0.01296	-0.01489	-0.00855	-0.00001	-0.01801	0.01147	0.004	-0.00019	-0.01375	0.05623	0.02982	-0.00314
8.Alcohol/drug related	0.01705	-0.00082	0.00875	-0.02366	0.02213	-0.01636	-0.008	-0.05008	-0.06543	0.037	0.12709	0.01915	-0.06049	-0.1459	0.0367
9.Vehicle age (Year 5 or newer)	-0.04945	-0.01096	-0.01595	0.01927	0.00305	0.00441	-0.00846	0.00591	-0.00396	0.007	-0.00901	-0.01517	0.03371	0.01714	-0.00657
10.Vehicle age (6-10 years)	-0.06389	0.02874	0.01258	-0.01769	0.00386	0.0064	-0.02136	0.00026	0.00726	0.011	-0.02206	-0.01601	0.06478	0.01688	-0.00861
11.Vehicle age (11-15 years)	-0.05394	0.06443	-0.00211	0.00539	-0.00622	0.00315	-0.01731	-0.02389	0.00633	0.015	0.01034	0.00288	0.03733	0.00868	0.01352
12.Vehicle age (Year 16 or older)	0.11445	-0.07802	-0.00047	-0.00094	0.00296	-0.00798	0.03015	0.02007	-0.00839	-0.03	0.01034	0.01503	-0.0944	-0.0218	-0.00602
13.Automobile	-0.60506	-0.60274	0.00705	-0.00334	-0.00878	-0.00684	-0.04779	-0.10261	0.02565	0.079	-0.00762	-0.00939	0.14468	0.01817	-0.0153
14.Van	-0.0678	-0.06754	0.00068	-0.00354	-0.00332	0.00485	0.00968	-0.01045	-0.00039	0.012	-0.00978	0.03698	0.00071	0.01729	0.00358
15.Pickup truck camper-rv	1	-0.18272	0.00069	-0.00644	0.01886	-0.0017	0.03412	0.07485	-0.01765	-0.07	0.01959	-0.00387	-0.22731	-0.0474	0.02866
16.Sport utility vehicle	-0.18272	1	-0.00979	0.01273	-0.00587	0.00801	0.02248	0.06401	-0.01498	-0.04	-0.00522	0.00004	0.03872	0.01847	-0.01021
17.Straight following	0.00069	-0.00979	1	-0.71769	-0.26478	-0.47347	-0.00835	-0.05127	-0.05196	0.064	0.06655	-0.03571	0.00934	-0.01203	0.01564
18.Turn/changing lanes maneuver	-0.00644	0.01273	-0.71769	1	-0.05694	-0.10182	-0.024	0.00953	0.04267	-0.02	-0.04858	0.03881	0.00234	0.01007	-0.01646
19.Avoiding maneuver	0.01886	-0.00587	-0.26478	-0.05694	1	-0.03756	-0.01694	-0.02144	0.00689	0.016	0.00288	0.00524	-0.02854	-0.00657	0.02101
20.Stopped/parking/backing maneuver	-0.0017	0.00801	-0.47347	-0.10182	-0.03756	1	0.05419	0.09776	0.03619	-0.1	-0.06478	0.00683	0.00507	0.0342	-0.01718
21.No damage	0.03412	0.02248	-0.00835	-0.024	-0.01694	0.05419	1	-0.06169	-0.07817	-0.09	-0.03326	-0.00571	-0.00903	-0.00268	0.00168
22.Minor damage	0.07485	0.06401	-0.05127	0.00953	-0.02144	0.09776	-0.06169	1	-0.35298	-0.41	-0.15019	-0.02167	-0.00531	0.04169	-0.02445
23.Functional damage	-0.01765	-0.01498	-0.05196	0.04267	0.00689	0.03619	-0.07817	-0.35298	1	-0.52	-0.19032	-0.01258	0.01384	0.06507	-0.04197
24.Disabling damage	-0.06709	-0.04176	0.06375	-0.01769	0.01587	-0.09779	-0.0913	-0.41227	-0.52243	1	-0.22229	0.02594	0.0249	-0.02919	-0.00474
25.Destroyed damage	0.01959	-0.00522	0.06655	-0.04858	0.00288	-0.06478	-0.03326	-0.15019	-0.19032	-0.22	1	0.01033	-0.05347	-0.12085	0.12146
26.Driver with passengers	-0.00387	0.00004	-0.03571	0.03881	0.00524	0.00683	-0.00571	-0.02167	-0.01258	0.026	0.01033	1	0.00635	-0.01663	-0.00551
27.Female driver	-0.22731	0.03872	0.00934	0.00234	-0.02854	0.00507	-0.00903	-0.00531	0.01384	0.025	-0.05347	0.00635	1	0.0617	-0.03335
28.Driver safety belt used	-0.0474	0.01847	-0.01203	0.01007	-0.00657	0.0342	-0.00268	0.04169	0.06507	-0.03	-0.12085	-0.01663	0.0617	1	-0.20539
29.Ejected	0.02866	-0.01021	0.01564	-0.01646	0.02101	-0.01718	0.00168	-0.02445	-0.04197	-0	0.12146	-0.00551	-0.03335	-0.20539	1
30.Trapped	0.0069	0.01806	0.00952	0.00031	0.00332	-0.01893	-0.00854	-0.03854	-0.04884	-0.01	0.16666	0.00959	0.01318	-0.06602	-0.00484
31.Fatal injury/injury incapacitating	0.00894	-0.00507	0.02393	-0.01687	0.00657	-0.02239	-0.01147	-0.04642	-0.06083	-0.01	0.20747	0.01266	-0.00698	-0.12795	0.25064
32.Injury not incapacitating /possible injury	0.00188	-0.01923	0.04538	-0.03654	0.02424	-0.05289	-0.04058	-0.16559	-0.17503	0.17	0.27153	-0.01028	0.05119	-0.14494	0.07972
33.Not injured	-0.00329	0.02212	-0.04617	0.03912	-0.02811	0.05775	0.04448	0.16987	0.18116	-0.15	-0.31698	0.00426	-0.04311	0.21266	-0.14279
34.Teen passengers	-0.00264	-0.01425	-0.02706	0.03296	0.00356	-0.00076	0.00161	-0.02607	-0.01369	0.022	0.02382	0.73647	-0.03783	-0.00903	-0.00606
35.Speed limit<35 mph	0.00159	0.00993	-0.06942	0.07171	-0.02061	0.02472	0.01034	0.07776	0.0545	-0.07	-0.08902	0.01251	-0.00005	-0.01156	-0.03093
36.Speed limit_35-60 mph	-0.00683	0.00257	0.05989	-0.04762	-0.02251	-0.01669	0.00721	-0.0216	-0.01394	0.024	0.01294	-0.01014	0.01372	0.02143	0.00196
37.Speed limit>60 mph	0.01353	-0.02446	0.02007	-0.03613	0.06403	-0.0219	-0.02668	-0.09046	-0.05705	0.076	0.11761	-0.00515	-0.02488	-0.01569	0.03563
38.Concrete road surface type	-0.02375	-0.01253	0.00206	0.00788	-0.01781	0.00025	0.00874	0.02226	0.01268	-0.01	-0.03768	0.00229	0.00488	0.03838	-0.02
39.Black top road surface	-0.02346	0.00898	-0.0159	0.00571	0.00714	0.01709	-0.00546	0.0076	0.0186	-0.01	-0.01715	-0.0273	0.00901	0.00912	-0.00436
40.Gravel/brick road surface type	0.09457	0.00744	0.03061	-0.02966	0.02103	-0.03639	-0.00475	-0.05942	-0.06119	0.049	0.10732	0.05176	-0.02968	-0.09438	0.04843
41.Wet/debris road surface condition	0.01497	-0.00289	-0.02157	-0.00213	0.00302	0.03597	-0.006	-0.00763	0.01357	-0	-0.00463	-0.00132	-0.00187	-0.0072	-0.0028
42.Curved road	-0.0002	-0.00493	0.01881	-0.01309	0.01232	-0.02167	-0.01957	-0.04782	-0.04199	0.053	0.05785	0.01893	-0.02658	-0.02109	0.00338
43.Work_zone_realeted	-0.0122	-0.00345	0.0068	-0.01605	-0.00384	0.01534	0.03189	-0.00787	0.01369	-0	-0.02623	-0.00682	-0.00047	0.0112	-0.01142
44.Multi lanes road	0.00016	-0.00035	0.02784	-0.01137	-0.00157	-0.02335	-0.00632	-0.01363	-0.00099	0.016	0.00364	0.00292	0.00403	0.02141	-0.01214
45.5.00-9.00-Morning	0.01467	-0.0053	0.00126	-0.01118	0.01251	0.00122	-0.01512	-0.0298	-0.00387	0.019	0.02266	-0.05861	-0.00658	0.01371	0.00442
46.9.00-13.00-Noon	0.00063	0.01255	-0.00881	0.00707	-0.01172	0.01054	0.00969	0.01477	0.02399	-0.03	-0.01569	-0.03155	0.01883	0.01295	-0.00912
47.13.00-17.00-Afternoon	-0.01199	0.0101	0.01	-0.01723	-0.00163	0.02346	0.00672	0.04815	0.04752	-0.05	-0.0656	-0.00036	0.02714	0.04999	-0.01543
48.17.00-21.00-Evening	-0.00819	-0.01277	-0.02031	0.03087	-0.01221	0.00857	0.01608	0.02461	0.00074	-0.01	-0.03396	0.05356	0.01374	0.011	0.00182
49.21.00-5.00-Night	0.0095	-0.0086	0.02179	-0.01096	0.0178	-0.06053	-0.02715	-0.08983	-0.09287	0.098	0.13579	0.02995	-0.07156	-0.11685	0.01974
50.Week end	0.02009	-0.00379	0.02671	-0.00742	0.00099	-0.04367	-0.00209	-0.05409	-0.0577	0.055	0.08539	0.03418	-0.02674	-0.04726	0.02247
51.On roadway	-0.00278	-0.01053	0.03378	-0.03178	0.0083	-0.01845	-0.00977	-0.00321	0.03165	-0.01	-0.03519	-0.00818	-0.00658	-0.00061	-0.01211
52.At Intersection	-0.02598	0.01812	-0.05906	0.06503	-0.06341	0.07265	0.03466	0.10144	0.07061	-0.09	-0.12823	0.00091	0.04657	0.07876	-0.0352
53.Off roadway crash	0.04165	-0.01256	0.03996	-0.05078	0.07638	-0.07567	-0.0362	-0.1343	-0.13608	0.132	0.21968	0.00818	-0.0545	-0.10353	0.06486
54.Dark	0.00693	-0.0194	0.00778	0.01197	0.00975	-0.05794	-0.02093	-0.075	-0.08617	0.089	0.1134	0.04761	-0.06422	-0.09712	0.02324
55.Adverse weather conditions	0.00089	-0.00023	-0.01918	0.00113	0.00636	0.02664	-0.00188	-0.00953	-0.00006	0.006	0.00054	0.00314	-0.00088	-0.0047	0.00073
56.Rural roads	0.12753	-0.03132	0.02451	-0.02665	0.05746	-0.04797	-0.02693	-0.11508	-0.09765	0.081	0.21252	0.03702	-0.03282	-0.09712	0.06424
57.Animal factors	0.01618	-0.01647	-0.01248	0.00012	0.02154	0.00747	-0.0055	-0.0173	-0.00953	0.018	0.01081	0.0168	-0.00475	0.00576	0.00432
58.Weather factors	0.01083	-0.01874	-0.02353	0.01287	0.02978	0.01053	-0.0043	-0.00668	-0.02117	0.017	0.02006	0.00961	-0.01175	-0.00189	-0.00623
59.Vision obstruction factors	0.00794	0.00807	-0.00398	0.00562	0.00697	-0.00286	-0.00465	-0.00785	0.01642	-0.01	0.00241	0.02102	-0.00438	-0.00349	0.02474
60.Vehicle factors	-0.01287	0.00695	-0.00376	0.00963	-0.01181	0.00076	-0.00184	-0.00653	-0.00083	0.008	-0.003	0.00903	-0.01189	0.00462	-0.0054
61.Road factors	0.01261	-0.01374	-0.00514	-0.01802	0.01061	0.02725	-0.00213	-0.00959	-0.01603	0.019	0.00611	0.02726	-0.01037	0.00429	0.005

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.1 (continued)

Variable	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
1.Cell phone	0.03133	0.02232	0.01117	-0.0189	-0.04332	-0.01016	0.0081	0.00196	-0.01231	0.011	0.00187	-0.00414	0.01853	-0.00797	-0.00874
2.Other electronic devices	-0.00451	-0.01001	0.01616	-0.0099	-0.01339	-0.03318	0.01794	0.01778	-0.00615	0.01	-0.00727	-0.01703	0.00212	0.00824	0.00116
3.In/on vehicle distraction	0.00819	0.01351	0.02675	-0.02568	0.01901	-0.01226	0.0128	-0.00168	-0.01129	0.003	0.0163	-0.04193	0.00886	-0.00671	0.01265
4.External distraction	-0.0067	-0.00811	-0.01507	0.01484	-0.00523	-0.02891	0.04913	-0.03633	0.03135	-0.02	-0.01892	-0.01398	-0.02165	-0.00669	0.01262
5.Inattention	-0.04534	-0.03985	-0.09503	0.0996	0.03936	0.08542	-0.00901	-0.11715	0.00435	-0	-0.0038	0.05489	-0.04464	0.01088	-0.01489
6.Valid licensed	-0.00457	-0.0187	-0.02266	0.03451	-0.02491	-0.0605	0.04931	0.01736	-0.01369	0.025	-0.02598	-0.0061	-0.01694	0.0041	-0.00018
7.Restricted license	-0.00571	-0.01236	-0.00729	0.01395	-0.01198	-0.03348	0.03202	0.0012	0.00706	-0.01	0.01513	-0.00474	-0.00901	0.00047	0.00165
8.Alcohol/drug related	0.07349	0.11669	0.09419	-0.12028	0.02229	0.00176	-0.01194	0.0195	-0.00022	-0.03	0.06074	0.00079	0.03101	-0.00047	-0.00481
9.Vehicle age (Year 5 or newer)	0.00242	-0.00237	-0.01835	0.01839	-0.01102	0.00449	-0.0102	0.00473	-0.00145	0.01	-0.01562	-0.01055	0.02293	0.00267	0.00403
10.Vehicle age (6-10 years)	-0.00465	-0.00451	-0.00523	0.00576	-0.01459	-0.01654	0.0163	-0.00133	-0.01135	0.015	-0.00785	-0.02123	0.01238	0.01115	0.0081
11.Vehicle age (11-15 years)	0.00537	0.01266	-0.00152	0.00441	-0.00724	-0.01374	-0.01036	0.03782	0.00772	-0	-0.01411	0.00553	-0.01506	0.00659	-0.00291
12.Vehicle age (Year 16 or older)	-0.00418	-0.00873	0.01122	-0.01226	0.02124	0.02204	0.0025	-0.03565	0.00224	-0.01	0.0234	0.01389	-0.00227	-0.01475	-0.00481
13.Automobile	-0.01737	-0.00408	0.01809	-0.01827	0.01503	-0.01083	0.00693	0.0047	0.02979	0.009	-0.07701	-0.00991	0.00626	0.01107	0.00494
14.Van	-0.00517	0.00358	-0.01523	0.0122	-0.00788	0.00456	-0.01027	0.01189	-0.00687	0.007	-0.00541	0.00145	-0.00649	0.00325	-0.01244
15.Pickup truck camper-rv	0.0069	0.00894	0.00188	-0.00329	-0.00264	0.00159	-0.00683	0.01353	-0.02375	-0.02	0.09457	0.01497	-0.0002	-0.0122	0.00016
16.Sport utility vehicle	0.01806	-0.00507	-0.01923	0.02212	-0.01425	0.00993	0.00257	-0.02446	-0.01253	0.009	0.00744	-0.00289	-0.00493	-0.00345	-0.00035
17.Straight following	0.00952	0.02393	0.04538	-0.04617	-0.02706	-0.06942	0.05989	0.02007	0.00206	-0.02	0.03061	-0.02157	0.01881	0.0068	0.02784
18.Turn/changing lanes maneuver	0.00031	-0.01687	-0.03654	0.03912	0.03296	0.07171	-0.04762	-0.03613	0.00788	0.006	-0.02966	-0.00213	-0.01309	-0.01605	-0.01137
19.Avoiding maneuver	0.00332	0.00657	0.02424	-0.02811	0.00356	-0.02061	-0.02251	0.06403	-0.01781	0.007	0.02103	0.00302	0.01232	-0.00384	-0.00157
20.Stopped/parking/backing maneuver	-0.01893	-0.02239	-0.05289	0.05775	-0.00076	0.02472	-0.01669	-0.0219	0.00025	0.017	-0.03639	0.03597	-0.02167	0.01534	-0.02335
21.No damage	-0.00854	-0.01147	-0.04058	0.04448	0.00161	0.01034	0.00721	-0.02668	0.00874	-0.01	-0.00475	-0.006	-0.01957	0.03189	-0.00632
22.Minor damage	-0.03854	-0.04642	-0.16559	0.16987	-0.02607	0.07776	-0.0216	-0.09046	0.02226	0.008	-0.05942	-0.00763	-0.04782	-0.00787	-0.01363
23.Functional damage	-0.04884	-0.06083	-0.17503	0.18116	-0.01369	0.0545	-0.01394	-0.05705	0.01268	0.019	-0.06119	0.01357	-0.04199	0.01369	-0.00099
24.Disabling damage	-0.00822	-0.01125	0.16995	-0.15421	0.0216	-0.07398	0.02364	0.07632	-0.01108	-0.01	0.04915	-0.00368	0.0525	-0.0003	0.01569
25.Destroyed damage	0.16666	0.20747	0.27153	-0.31698	0.02382	-0.08902	0.01294	0.11761	-0.03768	-0.02	0.10732	-0.00463	0.05785	-0.02623	0.00364
26.Driver with passengers	0.00959	0.01266	-0.01028	0.00426	0.73647	0.01251	-0.01014	-0.00515	0.00229	-0.03	0.05176	-0.00132	0.01893	-0.00682	0.00292
27.Female driver	0.01318	-0.00698	0.05119	-0.04311	-0.03783	-0.00005	0.01372	-0.02488	0.00488	0.009	-0.02968	-0.00187	-0.02658	-0.00047	0.00403
28.Driver safety belt used	-0.06602	-0.12795	-0.14494	0.21266	-0.00903	-0.01156	0.02143	-0.01569	0.03838	0.009	-0.09438	-0.0072	-0.02109	0.0112	0.02141
29.Ejected	-0.00484	0.25064	0.07972	-0.14279	-0.00606	-0.03093	0.00196	0.03563	-0.02	-0	0.04843	-0.0028	0.00338	-0.01142	-0.01214
30.Trapped	1	0.30765	0.08541	-0.16374	0.00474	-0.03639	-0.01568	0.08058	-0.01399	-0	0.03207	-0.00453	0.02293	0.01102	0.00241
31.Fatal injury/injury incapacitating	0.30765	1	-0.03721	-0.23884	0.01002	-0.04564	-0.01912	0.09964	-0.01976	0.009	0.01716	-0.01793	0.03148	-0.00367	0.00156
32.Injury not incapacitating /possible injury	0.08541	-0.03721	1	-0.92322	-0.005	-0.09108	0.02139	0.1025	-0.02907	-0.02	0.09446	-0.01361	0.03489	-0.01493	-0.00156
33.Not injured	-0.16374	-0.23884	-0.92322	1	0.00028	0.08755	-0.00692	-0.11897	0.03339	0.016	-0.09519	0.01132	-0.04019	0.0159	0.00541
34.Teen passengers	0.00474	0.01002	-0.005	0.00028	1	0.00513	0.00141	-0.01196	-0.01662	-0.01	0.05353	-0.00395	0.02133	-0.00735	-0.00348
35.Speed limit<35 mph	-0.03639	-0.04564	-0.09108	0.08755	0.00513	1	-0.77882	-0.21621	-0.04399	0.054	-0.0277	-0.0155	-0.00489	-0.04653	-0.07465
36.Speed limit_35-60 mph	-0.01568	-0.01912	0.02139	-0.00692	0.00141	-0.77882	1	-0.40283	-0.0135	-0.02	0.0662	0.01069	-0.05875	0.01919	0.09055
37.Speed limit>60 mph	0.08058	0.09964	0.1025	-0.11897	-0.01196	-0.21621	-0.40283	1	0.09263	-0.05	-0.07149	0.00509	0.09697	0.03785	-0.01047
38.Concrete road surface type	-0.01399	-0.01976	-0.02907	0.03339	-0.01662	-0.04399	-0.0135	0.09263	1	-0.87	-0.13261	0.0062	0.00762	0.0446	-0.01757
39.Black top road surface	-0.00208	0.00905	-0.01875	0.01571	-0.01021	0.05383	-0.01875	-0.05222	-0.87347	1	-0.35798	-0.00868	-0.02982	-0.02744	0.07234
40.Gravel/brick road surface type	0.03207	0.01716	0.09446	-0.09519	0.05353	-0.0277	0.0662	-0.07149	-0.13261	-0.36	1	0.00612	0.04523	-0.03434	-0.09513
41.Wet/debris road surface condition	-0.00453	-0.01793	-0.01361	0.01132	-0.00395	-0.0155	0.01069	0.00509	0.0062	-0.01	0.00612	1	0.01171	-0.02918	-0.007
42.Curved road	0.02293	0.03148	0.03489	-0.04019	0.02133	-0.00489	-0.05875	0.09697	0.00762	-0.03	0.04523	0.01171	1	0.0038	-0.05915
43.Work_zone_realeted	0.01102	-0.00367	-0.01493	0.0159	-0.00735	-0.04653	0.01919	0.03785	0.0446	-0.03	-0.03434	-0.02918	0.0038	1	-0.01627
44.Multi lanes road	0.00241	0.00156	-0.00156	0.00541	-0.00348	-0.07465	0.09055	-0.01047	-0.01757	0.072	-0.09513	-0.007	-0.05915	-0.01627	1
45.5.00-9.00-Morning	0.01302	0.01545	0.01129	-0.01911	-0.05836	-0.0306	-0.00592	0.0607	0.00725	0.004	-0.01975	0.06151	0.01584	-0.01919	-0.00163
46.9.00-13.00-Noon	0.00456	-0.00213	-0.0018	0.00452	-0.03644	0.02813	-0.01157	-0.01848	-0.01028	0.023	-0.02643	0.00035	-0.0105	0.01645	0.00019
47.13.00-17.00-Afternoon	-0.01281	-0.02834	-0.05251	0.06303	-0.00105	0.04339	-0.00066	-0.06882	0.00326	0.018	-0.04266	-0.03251	-0.06522	0.01302	0.01525
48.17.00-21.00-Evening	-0.01477	0.00321	-0.02753	0.02737	0.04853	-0.03466	0.03454	-0.00377	0.00595	-0	-0.0103	-0.02588	-0.01109	-0.00524	-0.00329
49.21.00-5.00-Night	0.01939	0.02155	0.10166	-0.11017	0.04374	-0.0187	-0.02382	0.06182	-0.00826	-0.05	0.12563	0.01471	0.10463	-0.00952	-0.01644
50.Week end	0.01836	0.03689	0.06514	-0.06724	0.03307	-0.01946	-0.01622	0.05644	-0.0168	-0.01	0.06315	0.0006	0.04981	-0.02224	0.00684
51.On roadway	-0.01166	-0.02686	-0.03223	0.03876	-0.00632	0.00973	0.00526	-0.01756	-0.0003	0.008	-0.01215	-0.00581	-0.04122	0.06148	0.00969
52.At Intersection	-0.03127	-0.04577	-0.09556	0.10237	-0.00296	0.03626	0.04295	-0.11608	0.05648	0.015	-0.14248	0.00024	-0.11961	-0.02535	0.02711
53.Off roadway crash	0.05889	0.09482	0.17051	-0.18785	0.0108	-0.06581	-0.06409	0.18482	-0.07699	-0.03	0.20806	0.00724	0.21847	-0.04637	-0.04346
54.Dark	0.01646	0.02714	0.07628	-0.08715	0.05434	-0.04745	0.00186	0.06514	-0.00863	-0.05	0.11407	0.05762	0.08872	-0.0227	-0.01303
55.Adverse weather conditions	0.00659	-0.0117	-0.008	0.00667	-0.00006	-0.02797	0.02307	0.0053	0.00773	-0	-0.01039	0.78604	0.01098	-0.01642	-0.00183
56.Rural roads	0.0638	0.07761	0.17105	-0.17941	0.03594	-0.15099	0.03757	0.17225	-0.17198	-0.01	0.36253	-0.00077	0.06913	-0.04289	-0.02475
57.Animal factors	-0.00463	-0.0003	0.01101	-0.01041	0.02447	-0.01324	-0.00198	0.02339	-0.02278	0.009	0.02261	0.2249	0.0129	-0.00072	0.00687
58.Weather factors	0.01434	-0.00922	0.0294	-0.02494	0.008	-0.01851	-0.00975	0.04538	-0.01043	0.004	0.01292	0.11552	-0.00736	-0.01158	-0.0172
59.Vision obstruction factors	-0.0029	0.01469	0.00672	-0.00937	0.00666	-0.00589	-0.00009	0.00473	-0.00579	0.002	0.00708	0.02784	0.00343	0.00395	0.00733
60.Vehicle factors	-0.00595	-0.00799	-0.00686	0.01079	0.00432	0.00754	0.00096	-0.01252	-0.00719	0.007	0.00103	0.02945	0.00227	0.01243	-0.00483
61.Road factors	0.00209	-0.00676	0.01305	-0.01323	0.01651	-0.04606	-0.0018	0.06656	-0.00387	4E-04	0.0064	0.31498	0.01538	0.06695	-0.0083

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.1 (continued)

Variable	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
1.Cell phone	-0.02043	-0.01775	-0.02731	0.01074	0.06872	0.02141	-0.02332	-0.01979	0.05899	0.06517	0.00447	0.01166	-0.02588	-0.01488	-0.00719	-0.02432
2.Other electronic devices	-0.01606	0.0005	-0.00378	0.00878	0.0102	0.02114	0.0008	-0.02223	0.02932	0.00255	-0.01665	0.00483	-0.01057	-0.00399	-0.01243	-0.00047
3.In/on vehicle distraction	-0.01288	0.00415	-0.00258	0.01568	-0.00718	0.01486	-0.02725	-0.02736	0.07146	-0.00585	-0.03435	0.0418	-0.01191	-0.01623	0.01374	-0.00623
4.External distraction	-0.02303	-0.00562	0.00999	0.02484	-0.01499	-0.00178	0.01021	0.02391	-0.04649	-0.01477	-0.01362	-0.0504	0.01064	-0.00701	-0.01405	-0.00282
5.Inattention	-0.02388	0.03836	0.06696	0.01308	-0.13364	-0.10692	0.05178	0.1227	-0.23468	-0.11079	0.04288	-0.11112	0.02442	0.03043	0.01366	0.02263
6.Valid licensed	0.01396	-0.01257	0.0238	0.02145	-0.06091	-0.02974	0.01028	0.01326	-0.02775	-0.02958	0.00103	0.03343	0.00397	-0.0031	0.0037	0.02712
7.Restricted license	0.03815	-0.00573	-0.00673	-0.00437	-0.01805	-0.01954	-0.01257	0.00906	0.00418	-0.00892	0.0001	0.01657	0.01185	-0.00268	-0.00001	-0.00272
8.Alcohol/drug related	-0.00998	-0.04779	-0.08606	-0.02798	0.22727	0.11253	-0.03448	-0.07092	0.13687	0.18262	0.00013	0.06763	-0.00174	-0.00259	-0.00544	0.00005
9.Vehicle age (Year 5 or newer)	0.00148	-0.00827	-0.00452	-0.00157	0.01781	0.00674	-0.0139	-0.00469	0.02575	0.01269	-0.00905	-0.01205	-0.01066	-0.00509	-0.00569	-0.00419
10.Vehicle age (6-10 years)	-0.01091	0.01413	-0.00834	0.00413	0.00222	0.00341	-0.01756	0.01111	0.00722	0.00731	-0.01881	-0.00741	0.0038	-0.01878	-0.02837	-0.01752
11.Vehicle age (11-15 years)	0.00336	0.00304	-0.00982	0.00744	-0.00252	-0.0012	-0.0075	0.00614	0.0018	0.00887	0.00609	-0.00386	0.00506	0.00607	-0.01014	0.01694
12.Vehicle age (Year 16 or older)	0.00492	-0.0092	0.01592	-0.0088	-0.00645	-0.00271	0.02384	-0.01273	-0.0142	-0.01766	0.01092	0.01481	-0.00351	0.00994	0.03207	-0.00321
13.Automobile	-0.00952	-0.01483	0.0023	0.01645	0.00523	-0.00952	0.01628	0.0021	-0.02384	0.01438	-0.00107	-0.07352	-0.00391	0.00771	0.00696	-0.00146
14.Van	0.00669	0.01548	-0.00478	0.00012	-0.0173	-0.00905	-0.01891	0.01265	0.00555	-0.01355	0.00089	-0.00224	0.01286	-0.0049	-0.00716	0.00496
15.Pickup truck camper-rv	0.01467	0.00063	-0.01199	-0.00819	0.0095	0.02009	-0.00278	-0.02598	0.04165	0.00693	0.00089	0.12753	0.01618	0.01083	-0.01287	0.01261
16.Sport utility vehicle	-0.0053	0.01255	0.0101	-0.01277	-0.0086	-0.00379	-0.01053	0.01812	-0.01256	-0.0194	-0.00023	-0.03132	-0.01647	-0.01874	0.00695	-0.01374
17.Straight following	0.00126	-0.00881	0.01	-0.02031	0.02179	0.02671	0.03378	-0.05906	0.03996	0.00778	-0.01918	0.02451	-0.01248	-0.02353	-0.00376	-0.00514
18.Turn/changing lanes maneuver	-0.01118	0.00707	-0.01723	0.03087	-0.01096	-0.00742	-0.03178	0.06503	-0.05078	0.01197	0.00113	-0.02665	0.00012	0.01287	0.00963	-0.01802
19.Avoiding maneuver	0.01251	-0.01172	-0.00163	-0.01221	0.0178	0.00099	0.0083	-0.06341	0.07638	0.00975	0.00636	0.05746	0.02154	0.02978	-0.01181	0.01061
20.Stopped/parking/backing maneuver	0.00122	0.01054	0.02346	0.00857	-0.06053	-0.04367	-0.01845	0.07265	-0.07567	-0.05794	0.02664	-0.04797	0.00747	0.01053	0.00076	0.02725
21.No damage	-0.01512	0.00969	0.00672	0.01608	-0.02715	-0.00209	-0.00977	0.03466	-0.0362	-0.02093	-0.00188	-0.02693	-0.0055	-0.0043	-0.00184	-0.00213
22.Minor damage	-0.0298	0.01477	0.04815	0.02461	-0.08983	-0.05409	-0.00321	0.10144	-0.1343	-0.075	-0.00953	-0.11508	-0.0173	-0.00668	-0.00653	-0.00959
23.Functional damage	-0.00387	0.02399	0.04752	0.00074	-0.09287	-0.0577	0.03165	0.07061	-0.13608	-0.08617	-0.00006	-0.09765	-0.00953	-0.02117	-0.00083	-0.01603
24.Disabling damage	0.01917	-0.0295	-0.05218	-0.00642	0.0983	0.05536	-0.00551	-0.09166	0.1318	0.08946	0.00561	0.08053	0.01809	0.01709	0.00755	0.01887
25.Destroyed damage	0.02266	-0.01569	-0.0656	-0.03396	0.13579	0.08539	-0.03519	-0.12823	0.21968	0.1134	0.00054	0.21252	0.01081	0.02006	-0.003	0.00611
26.Driver with passengers	-0.05861	-0.03155	-0.00036	0.05356	0.02995	0.03418	-0.00818	0.00091	0.00818	0.04761	0.00314	0.03702	0.0168	0.00961	0.00903	0.02726
27.Female driver	-0.00658	0.01883	0.02714	0.01374	-0.07156	-0.02674	-0.00658	0.04657	-0.0545	-0.06422	-0.00088	-0.03282	-0.00475	-0.01175	-0.01189	-0.01037
28.Driver safety belt used	0.01371	0.01295	0.04999	0.011	-0.11685	-0.04726	-0.00061	0.07876	-0.10353	-0.09712	-0.0047	-0.09712	0.00576	-0.00189	0.00462	0.00429
29.Ejected	0.00442	-0.00912	-0.01543	0.00182	0.01974	0.02247	-0.01211	-0.0352	0.06486	0.02324	0.00073	0.06424	0.00432	-0.00623	-0.0054	0.005
30.Trapped	0.01302	0.00456	-0.01281	-0.01477	0.01939	0.01836	-0.01166	-0.03127	0.05889	0.01646	0.00659	0.0638	-0.00463	0.01434	-0.00595	0.00209
31.Fatal injury/injury incapacitating	0.01545	-0.00213	-0.02834	0.00321	0.02155	0.03689	-0.02686	-0.04577	0.09482	0.02714	-0.0117	0.07761	-0.0003	-0.00922	-0.00799	-0.00676
32.Injury not incapacitating /possible injury	0.01129	-0.0018	-0.05251	-0.02753	0.10166	0.06514	-0.03223	-0.09556	0.17051	0.07628	-0.008	0.17105	0.01101	0.0294	-0.00686	0.01305
33.Not injured	-0.01911	0.00452	0.06303	0.02737	-0.11017	-0.06724	0.03876	0.10237	-0.18785	-0.08715	0.00667	-0.17941	-0.01041	-0.02494	0.01079	-0.01323
34.Teen passengers	-0.05836	-0.03644	-0.00105	0.04853	0.04374	0.03307	-0.00632	-0.00296	0.0108	0.05434	-0.00006	0.03594	0.02447	0.008	0.00432	0.01651
35.Speed limit<35 mph	-0.0306	0.02813	0.04339	-0.03466	-0.0187	-0.01946	0.00973	0.03626	-0.06581	-0.04745	-0.02797	-0.15099	-0.01324	-0.01851	0.00754	-0.04606
36.Speed limit_35-60 mph	-0.00592	-0.01157	-0.00066	0.03454	-0.02382	-0.01622	0.00526	0.04295	-0.06409	0.00186	0.02307	0.03757	-0.00198	-0.00975	0.00096	-0.0018
37.Speed limit>60 mph	0.0607	-0.01848	-0.06882	-0.00377	0.06182	0.05644	-0.01756	-0.11608	0.18482	0.06514	0.0053	0.17225	0.02339	0.04538	-0.01252	0.06656
38.Concrete road surface type	0.00725	-0.01028	0.00326	0.00595	-0.00826	-0.0168	-0.0003	0.05648	-0.07699	-0.00863	0.00773	-0.17198	-0.02278	-0.01043	-0.00719	-0.00387
39.Black top road surface	0.00387	0.02292	0.01839	-0.00214	-0.05399	-0.01417	0.00759	0.01512	-0.02873	-0.04863	-0.00258	-0.01394	0.00898	0.00393	0.00658	0.00044
40.Gravel/brick road surface type	-0.01975	-0.02643	-0.04266	-0.0103	0.12563	0.06315	-0.01215	-0.14248	0.20806	0.11407	-0.01039	0.36253	0.02261	0.01292	0.00103	0.0064
41.Wet/debris road surface condition	0.06151	0.00035	-0.03251	-0.02588	0.01471	0.0006	-0.00581	0.00024	0.00724	0.05762	0.78604	-0.00077	0.2249	0.11552	0.02945	0.31498
42.Curved road	0.01584	-0.0105	-0.06522	-0.01109	0.10463	0.04981	-0.04122	-0.11961	0.21847	0.08872	0.01098	0.06913	0.0129	-0.00736	0.00227	0.01538
43.Work_zone_realeted	-0.01919	0.01645	0.01302	-0.00524	-0.00952	-0.02224	0.06148	-0.02535	-0.04637	-0.0227	-0.01642	-0.04289	-0.00072	-0.01158	0.01243	0.06695
44.Multi lanes road	-0.00163	0.00019	0.01525	-0.00329	-0.01644	0.00684	0.00969	0.02711	-0.04346	-0.01303	-0.00183	-0.02475	0.00687	-0.0172	-0.00483	-0.0083
45.5.00-9.00-Morning	1	-0.18052	-0.29034	-0.22385	-0.14751	-0.08865	0.02077	-0.04364	0.03464	-0.1356	0.04093	0.04178	0.05613	0.04834	0.01796	0.03103
46.9.00-13.00-Noon	-0.18052	1	-0.32003	-0.24674	-0.1626	0.05642	-0.00139	0.02513	-0.0318	-0.23845	-0.00672	-0.039	-0.00421	-0.01086	0.01364	0.0129
47.13.00-17.00-Afternoon	-0.29034	-0.32003	1	-0.39684	-0.26151	-0.0623	0.0224	0.06272	-0.11445	-0.36965	-0.02266	-0.05912	-0.03036	-0.02025	-0.00797	-0.02887
48.17.00-21.00-Evening	-0.22385	-0.24674	-0.39684	1	-0.20163	-0.04595	-0.00421	0.05447	-0.0716	0.23458	-0.00801	-0.03266	-0.00362	-0.00651	-0.00325	-0.01126
49.21.00-5.00-Night	-0.14751	-0.1626	-0.26151	-0.20163	1	0.1795	-0.0478	-0.1429	0.25784	0.65455	0.00711	0.12761	-0.00542	-0.00074	-0.01869	0.0076
50.Week end	-0.08865	0.05642	-0.0623	-0.04595	0.1795	1	-0.03907	-0.07109	0.1458	0.15142	-0.00068	0.07541	0.00038	-0.00717	-0.00482	0.01377
51.On roadway	0.02077	-0.00139	0.0224	-0.00421	-0.0478	-0.03907	1	-0.72107	-0.3013	-0.05279	-0.00283	-0.02133	0.00554	-0.00081	-0.01041	0.01955
52.At Intersection	-0.04364	0.02513	0.06272	0.05447	-0.1429	-0.07109	-0.72107	1	-0.43728	-0.09937	0.00216	-0.23423	-0.01066	-0.00676	0.00523	-0.03389
53.Off roadway crash	0.03464	-0.0318	-0.11445	-0.0716	0.25784	0.1458	-0.3013	-0.43728	1	0.2025	-0.00001	0.34959	0.00715	0.00885	0.00683	0.0215
54.Dark	-0.1356	-0.23845	-0.36965	0.23458	0.65455	0.15142	-0.05279	-0.09937	0.2025	1	0.05368	0.11455	0.01968	0.00182	-0.0192	0.02778
55.Adverse weather conditions	0.04093	-0.00672	-0.02266	-0.00801	0.00711	-0.00068	-0.00283	0.00216	-0.00001	0.05368	1	0.00116	0.27615	0.14799	0.03093	0.25458
56.Rural roads	0.04178	-0.039	-0.05912	-0.03266	0.12761	0.07541	-0.02133	-0.23423	0.34959	0.11455	0.00116	1	0.05068	0.025	0.00127	0.02682
57.Animal factors	0.05613	-0.00421	-0.03036	-0.00362	-0.00542	0.00038	0.00554	-0.01066	0.00715	0.01968	0.27615	0.05068	1	-0.01442	0.04656	0.21948
58.Weather factors	0.04834	-0.01086	-0.02025	-0.00651	-0.00074	-0.00717	-0.00081	-0.00676	0.00885	0.00182	0.14799	0.025	-0.01442	1	0.00186	0.13647
59.Vision obstruction factors	0.02548	0.00169	-0.02089	0.00787	-0.00887	0.00504	0.00268	-0.00452	0.00301	0.00408	0.04869	0.01043	-0.0061	-0.00373	0.0414	0.06096
60.Vehicle factors	0.01796	0.01364	-0.00797	-0.00325	-0.01869	-0.00482	-0.01041	0.00523	0.00683	-0.0192	0.03093	0.00127	0.04656	0.00186	1	0.03723
61.Road factors	0.03103	0.0129	-0.02887	-0.01126	0.0076	0.01377	0.01955	-0.03389	0.0215	0.02778	0.25458	0.02682	0.21948	0.13647	0.03723	1

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.2 Correlation Matrix for Crash Type Model of Young-Adult Drivers

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.Cell phone	1	-0.0281	-0.07204	-0.03813	-0.36087	0.00851	0.01117	0.08902	-0.00517	0.00695	0.00842	-0.00973	0.0136	-0.017	-0.0053
2.Other electronic devices	-0.0281	1	-0.04472	-0.02367	-0.224	0.02812	0.00471	-0.00616	0.0057	0.02516	0.00301	-0.0262	0.00167	-0.01382	-0.00922
3.In/on vehicle distraction	-0.07204	-0.04472	1	-0.06069	-0.57429	0.02239	0.01208	-0.03044	0.01232	0.01361	-0.01879	0.00133	0.00803	-0.00466	-0.00977
4.External distraction	-0.03813	-0.02367	-0.06069	1	-0.30401	0.01898	0.01337	-0.03754	0.00963	-0.00511	0.00516	-0.00673	-0.00407	0.00457	-0.00451
5.Inattention	-0.36087	-0.224	-0.57429	-0.30401	1	-0.03154	-0.0217	-0.04612	-0.02325	-0.02417	0.01551	0.01529	0.0034	0.01155	-0.00691
6.Valid licensed	0.00851	0.02812	0.02239	0.01898	-0.03154	1	0.13635	-0.0794	0.052	0.0796	-0.00145	-0.09171	0.02239	-0.03143	0.01547
7.Restricted license	0.01117	0.00471	0.01208	0.01337	-0.0217	0.13635	1	-0.03397	0.00772	0.02658	-0.00426	-0.02102	0.03	-0.0005	-0.04087
8.Alcohol/drug related	0.08902	-0.00616	-0.03044	-0.03754	-0.04612	-0.0794	-0.03397	1	-0.00541	-0.01306	-0.00504	0.01959	-0.01318	-0.02001	0.0374
9.Vehicle age (Year 5 or newer)	-0.00517	0.0057	0.01232	0.00963	-0.02325	0.052	0.00772	-0.00541	1	-0.14539	-0.19754	-0.21993	0.00026	-0.01143	-0.01907
10.Vehicle age (6-10 years)	0.00695	0.02516	0.01361	-0.00511	-0.02417	0.0796	0.02658	-0.01306	-0.14539	1	-0.36478	-0.40612	0.02526	-0.02689	-0.03053
11.Vehicle age (11-15 years)	0.00842	0.00301	-0.01879	0.00516	0.01551	-0.00145	-0.00426	-0.00504	-0.19754	-0.36478	1	-0.55179	-0.0209	0.019	-0.03351
12.Vehicle age (Year 16 or older)	-0.00973	-0.0262	0.00133	-0.00673	0.01529	-0.09171	-0.02102	0.01959	-0.21993	-0.40612	-0.55179	1	-0.00036	0.00925	0.06786
13.Automobile	0.0136	0.00167	0.00803	-0.00407	0.0034	0.02239	0.03	-0.01318	0.00026	0.02526	-0.0209	-0.00036	1	-0.23368	-0.59745
14.Van	-0.017	-0.01382	-0.00466	0.00457	0.01155	-0.03143	-0.0005	-0.02001	-0.01143	-0.02689	0.019	0.00925	-0.23368	1	-0.07283
15.Pickup truck camper-rv	-0.0053	-0.00922	-0.00977	-0.00451	-0.00691	0.01547	-0.04087	0.0374	-0.01907	-0.03053	-0.03351	0.06786	-0.59745	-0.07283	1
16.Sport utility vehicle	-0.00414	0.01367	-0.00005	0.0083	-0.00223	-0.03073	0.00263	-0.01047	0.02281	0.00941	0.05271	-0.06973	-0.59765	-0.07286	-0.18628
17.Straight following	0.05251	0.02891	0.06161	-0.01927	-0.11377	0.00463	0.00234	0.03996	-0.01058	-0.01325	-0.00757	0.02496	0.01657	-0.00902	-0.00272
18.Turn/changing lanes maneuver	-0.04626	-0.02067	-0.06879	0.033	0.10245	-0.01435	-0.00446	-0.02243	0.02182	0.02321	-0.00197	-0.0304	-0.0156	0.00895	-0.00404
19.Avoiding maneuver	-0.00578	-0.0034	0.00647	-0.00217	0.00093	-0.00168	-0.00731	-0.0093	-0.00508	-0.01249	0.02804	-0.01283	0.00645	-0.00246	0.01484
20.Stopped/parking/backing maneuver	-0.01849	-0.0172	-0.01502	-0.00852	0.06253	0.02743	0.01551	-0.04879	-0.00368	0.00999	-0.01237	0.00532	-0.00195	0.00103	-0.00483
21.No damage	-0.00865	0.00039	-0.00865	0.00707	0.02361	0.02241	0.01834	-0.0229	0.00427	-0.00572	-0.0197	0.01647	-0.04068	-0.00328	0.04257
22.Minor damage	-0.03432	-0.01614	-0.02023	0.01173	0.08461	0.02104	-0.00605	-0.08847	0.0046	0.00809	-0.00653	-0.0035	-0.09136	0.02253	0.05775
23.Functional damage	-0.04128	-0.01648	-0.01567	0.01334	0.07772	0.01529	-0.00636	-0.09024	-0.00462	-0.01257	0.0129	0.00273	0.02747	0.00015	-0.03288
24.Disabling damage	0.04865	0.02381	0.02415	-0.0096	-0.08875	-0.01264	0.01764	0.06967	0.00432	0.02245	-0.0103	-0.01079	0.07086	-0.01347	-0.0458
25.Destroyed damage	0.04398	0.0153	0.01777	-0.02331	-0.12556	-0.03118	-0.01123	0.18063	-0.0099	-0.0239	0.0177	0.00955	-0.01358	-0.00828	0.03287
26.Driver with passengers	-0.06461	-0.03575	0.07774	-0.01235	0.00492	-0.07388	-0.03013	0.01946	-0.01548	-0.02016	0.01428	0.01242	-0.01068	0.02994	-0.01819
27.Female driver	0.01823	-0.01171	0.03043	-0.00352	0.02384	0.05236	0.09467	-0.08668	0.02381	0.08978	0.03496	-0.12118	0.12916	-0.01074	-0.26358
28.Driver safety belt used	-0.01684	0.00261	0.02019	0.02362	0.00584	0.12912	0.04224	-0.19901	0.02995	0.03306	0.00741	-0.04612	0.01963	0.01843	-0.03958
29.Ejected	0.01304	-0.01006	-0.01404	-0.0068	0.00955	-0.05009	-0.01123	0.07815	-0.01223	0.01007	-0.01065	0.00158	-0.00767	-0.01286	0.02276
30.Trapped	0.01734	-0.01038	0.00763	-0.01408	-0.04347	0.00506	0.00717	0.10065	-0.00428	-0.01242	-0.01358	0.02647	-0.00167	0.00082	0.01056
31.Fatal injury/injury incapacitating	0.04341	-0.00249	-0.00106	-0.02027	-0.04781	-0.00739	0.00442	0.12188	-0.00689	-0.00916	0.00447	0.00453	-0.01362	0.0006	0.03558
32.Injury not incapacitating /possible injury	0.04623	0.00923	0.01835	-0.02567	-0.09261	-0.0346	-0.00811	0.10468	-0.00467	-0.02377	-0.01059	0.03327	0.01073	0.00219	-0.00946
33.Not injured	-0.05275	-0.00264	-0.0166	0.0355	0.09282	0.05597	0.01448	-0.13187	0.00872	0.03089	0.00984	-0.03812	-0.00336	-0.00779	0.00087
34.Teen passengers	-0.03048	-0.01733	-0.00373	-0.01393	0.02999	-0.0249	-0.01064	0.00431	-0.00358	-0.02283	0.00359	0.01898	0.01038	-0.01079	0.00276
35.Speed limit<35 mph	-0.01452	-0.03243	-0.00762	-0.01633	0.08431	-0.04261	-0.03069	-0.00008	-0.01881	-0.00413	-0.00725	0.01917	-0.01427	0.01042	-0.00753
36.Speed limit_35-60 mph	0.01656	0.02576	0.00302	0.03958	0.01212	0.02364	0.00477	-0.00887	0.00584	-0.01593	0.00209	0.01003	0.00931	-0.01064	-0.00758
37.Speed limit>60 mph	-0.00067	0.00215	0.00379	-0.03343	-0.12658	0.02267	0.03552	0.01244	0.01977	0.02944	0.00537	-0.04101	0.00759	-0.00145	0.01985
38.Concrete road surface type	-0.00681	-0.01074	-0.01378	0.02877	0.01079	-0.01894	0.00794	-0.02363	-0.01011	-0.00205	0.01251	-0.00663	0.00216	0.0159	-0.00807
39.Black top road surface	0.00451	0.0149	0.02174	-0.02695	-0.01132	0.0211	-0.00711	-0.00079	0.00682	0.00857	-0.0063	-0.00333	0.02591	-0.01024	-0.02577
40.Gravel/brick road surface type	0.00625	-0.0107	-0.01947	-0.00412	0.00269	-0.00091	0.0004	0.05836	0.00879	-0.01878	-0.0122	0.02329	-0.06975	-0.01209	0.08241
41.Wet/debris road surface condition	-0.02025	-0.01175	-0.03278	-0.02445	0.06344	-0.01131	-0.00697	-0.00555	-0.02177	-0.02154	0.00274	0.02819	0.00208	-0.00308	0.00217
42.Curved road	0.01558	-0.01081	-0.01459	-0.02036	-0.02275	-0.01269	-0.01151	0.04525	-0.00104	0.0098	0.00334	-0.01296	0.00171	-0.00526	0.01516
43.Work_zone_realeted	-0.00608	0.00179	-0.01498	0.00896	0.01616	0.03546	0.01535	-0.01333	0.00036	0.00771	0.01656	-0.02447	0.00482	-0.00469	-0.00655
44.Multi lanes road	0.00385	0.00976	0.0169	0.01115	-0.02686	0.01834	0.01538	0.01796	0.00941	-0.01081	0.01146	-0.00636	0.01945	-0.00419	-0.01612
45.5.00-9.00-Morning	-0.01765	-0.01401	-0.02757	-0.00459	-0.0361	0.00562	-0.00171	-0.04015	0.00789	0.03123	-0.00834	-0.02366	-0.00252	0.0085	0.00005
46.9.00-13.00-Noon	-0.02439	0.00266	0.00374	0.01794	0.03609	0.03166	0.02716	-0.0931	-0.0009	0.0176	-0.0002	-0.01563	-0.01751	0.01742	0.00954
47.13.00-17.00-Afternoon	-0.03184	-0.0127	0.01789	0.00995	0.0564	0.00725	0.00416	-0.12492	-0.01916	-0.02531	0.00524	0.02789	-0.00256	0.02068	-0.00463
48.17.00-21.00-Evening	-0.01809	0.02701	0.03014	0.01038	0.02151	0.0126	0.00796	-0.05424	0.01237	-0.00956	0.00056	0.00024	0.01792	-0.0133	-0.0295
49.21.00-5.00-Night	0.109	-0.00594	-0.03564	-0.04017	-0.1028	-0.06538	-0.04402	0.37122	0.00409	-0.00516	-0.00032	0.00427	0.00524	-0.04031	0.02978
50.Week end	0.02714	0.02509	-0.00457	-0.00858	-0.06627	-0.04237	-0.02718	0.15534	-0.00887	0.02178	-0.01258	-0.00156	0.00687	-0.01226	0.00479
51.On roadway	-0.03491	0.00404	-0.0087	0.0097	0.04506	0.01121	-0.00459	-0.03004	-0.03186	-0.00693	0.01161	0.01134	0.02303	-0.0012	-0.01603
52.At Intersection	-0.00536	0.00201	-0.00138	0.0098	0.09918	0.01808	0.0149	-0.12399	0.00407	0.0055	-0.00916	0.00175	-0.00302	0.00388	-0.02279
53.Off roadway crash	0.05318	-0.0071	0.01468	-0.02671	-0.19999	-0.03683	-0.01452	0.20831	0.03493	0.00077	-0.00137	-0.01671	-0.02483	-0.00561	0.05438
54.Dark	0.08322	0.00844	-0.02122	-0.03145	-0.09786	-0.06346	-0.03056	0.29537	0.02593	0.00186	-0.00415	-0.01027	0.00958	-0.03487	0.0108
55.Adverse weather conditions	-0.01101	-0.01022	-0.03726	-0.01285	0.04888	-0.01294	-0.00013	-0.00025	-0.01068	-0.0183	0.00092	0.0219	-0.00139	-0.01049	0.01178
56.Rural roads	0.01711	0.00276	0.01825	-0.03525	-0.1273	0.0274	0.01226	0.08855	0.02217	-0.01083	0.00958	-0.0109	-0.08764	-0.02355	0.14221
57.Animal factors	-0.01842	0.00241	-0.02712	0.01328	0.03172	0.01198	-0.00276	-0.02055	-0.01384	-0.00035	-0.00188	0.00941	-0.00065	-0.01171	0.00659
58.Weather factors	-0.01523	-0.00495	-0.02225	-0.00011	0.03104	0.00156	0.00429	-0.00909	0.02577	-0.01074	0.00588	-0.0098	-0.01376	0.00185	0.02336
59.Vision obstruction factors	0.00299	0.01259	-0.01327	0.00625	0.0073	-0.0086	0.00227	-0.00923	-0.00213	0.01356	-0.0129	0.00252	-0.01055	-0.00661	0.02111
60.Vehicle factors	-0.00712	-0.01105	0.00386	-0.01499	0.01455	-0.00931	-0.01389	-0.01969	-0.01094	-0.01941	-0.01273	0.03288	0.00778	-0.00088	0.01467
61.Road factors	-0.01399	0.0051	-0.00793	-0.00022	0.02029	-0.00631	-0.00791	-0.01843	0.00506	-0.00856	0.00461	-0.00167	-0.00722	0.00375	0.00957

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.2 (continued)

Variable	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1.Cell phone	-0.00414	0.05251	-0.04626	-0.00578	-0.01849	-0.00865	-0.03432	-0.04128	0.04865	0.04398	-0.06461	0.01823	-0.01684	0.01304	0.01734
2.Other electronic devices	0.01367	0.02891	-0.02067	-0.0034	-0.0172	0.00039	-0.01614	-0.01648	0.02381	0.0153	-0.03575	-0.01171	0.00261	-0.01006	-0.01038
3.In/on vehicle distraction	-0.00005	0.06161	-0.06879	0.00647	-0.01502	-0.00865	-0.02023	-0.01567	0.02415	0.01777	0.07774	0.03043	0.02019	-0.01404	0.00763
4.External distraction	0.0083	-0.01927	0.033	-0.00217	-0.00852	0.00707	0.01173	0.01334	-0.0096	-0.02331	-0.01235	-0.00352	0.02362	-0.0068	-0.01408
5.Inattention	-0.00223	-0.11377	0.10245	0.00093	0.06253	0.02361	0.08461	0.07772	-0.08875	-0.12556	0.00492	0.02384	0.00584	0.00955	-0.04347
6.Valid licensed	-0.03073	0.00463	-0.01435	-0.00168	0.02743	0.02241	0.02104	0.01529	-0.01264	-0.03118	-0.07388	0.05236	0.12912	-0.05009	0.00506
7.Restricted license	0.00263	0.00234	-0.00446	-0.00731	0.01551	0.01834	-0.00605	-0.00636	0.01764	-0.01123	-0.03013	0.09467	0.04224	-0.01123	0.00717
8.Alcohol/drug related	-0.01047	0.03996	-0.02243	-0.0093	-0.04879	-0.0229	-0.08847	-0.09024	0.06967	0.18063	0.01946	-0.08668	-0.19901	0.07815	0.10065
9.Vehicle age (Year 5 or newer)	0.02281	-0.01058	0.02182	-0.00508	-0.00368	0.00427	0.0046	-0.00462	0.00432	-0.0099	-0.01548	0.02381	0.02995	-0.01223	-0.00428
10.Vehicle age (6-10 years)	0.00941	-0.01325	0.02321	-0.01249	0.00999	-0.00572	0.00809	-0.01257	0.02245	-0.0239	-0.02016	0.08978	0.03306	0.01007	-0.01242
11.Vehicle age (11-15 years)	0.05271	-0.00757	-0.00197	0.02804	-0.01237	-0.0197	-0.00653	0.0129	-0.0103	0.0177	0.01428	0.03496	0.00741	-0.01065	-0.01358
12.Vehicle age (Year 16 or older)	-0.06973	0.02496	-0.0304	-0.01283	0.00532	0.01647	-0.0035	0.00273	-0.01079	0.00955	0.01242	-0.12118	-0.04612	0.00158	0.02647
13.Automobile	-0.59765	0.01657	-0.0156	0.00645	-0.00195	-0.04068	-0.09136	0.02747	0.07086	-0.01358	-0.01068	0.12916	0.01963	-0.00767	-0.00167
14.Van	-0.07286	-0.00902	0.00895	-0.00246	0.00103	-0.00328	0.02253	0.00015	-0.01347	-0.00828	0.02994	-0.01074	0.01843	-0.01286	0.00082
15.Pickup truck camper-rv	-0.18628	-0.00272	-0.00404	0.01484	-0.00483	0.04257	0.05775	-0.03288	-0.0458	0.03287	-0.01819	-0.26358	-0.03958	0.02276	0.01056
16.Sport utility vehicle	1	-0.01418	0.02078	-0.02167	0.00578	0.01034	0.05054	-0.00217	-0.03931	-0.01151	0.01959	0.10151	0.00819	-0.00999	-0.00851
17.Straight following	-0.01418	1	-0.6918	-0.28466	-0.48728	-0.02019	-0.07091	-0.0496	0.08622	0.05836	-0.02761	0.00462	-0.01403	0.02345	0.01455
18.Turn/changing lanes maneuver	0.02078	-0.6918	1	-0.06252	-0.10703	-0.01634	0.0311	0.04686	-0.03926	-0.04292	0.03561	-0.0083	0.01713	-0.01915	-0.00672
19.Avoiding maneuver	-0.02167	-0.28466	-0.06252	1	-0.04404	-0.01072	-0.03707	0.00479	0.0214	0.018	0.01362	-0.01159	-0.00609	-0.00461	-0.00521
20.Stopped/parking/backing maneuver	0.00578	-0.48728	-0.10703	-0.04404	1	0.06311	0.10486	0.02969	-0.10324	-0.06732	-0.00553	0.02143	0.0282	-0.00693	-0.02157
21.No damage	0.01034	-0.02019	-0.01634	-0.01072	0.06311	1	-0.0685	-0.0818	-0.0961	-0.03559	-0.01434	-0.01479	0.01374	-0.00954	-0.00983
22.Minor damage	0.05054	-0.07091	0.0311	-0.03707	0.10486	-0.0685	1	-0.35759	-0.42006	-0.15558	-0.02688	-0.00067	0.08428	-0.02756	-0.04299
23.Functional damage	-0.00217	-0.0496	0.04686	0.00479	0.02969	-0.0818	-0.35759	1	-0.50168	-0.1858	0.01189	0.03045	0.06756	-0.0394	-0.05134
24.Disabling damage	-0.03931	0.08622	-0.03926	0.0214	-0.10324	-0.0961	-0.42006	-0.50168	1	-0.21827	-0.00455	0.00669	-0.05008	0.00559	-0.01487
25.Destroyed damage	-0.01151	0.05836	-0.04292	0.018	-0.06732	-0.03559	-0.15558	-0.1858	-0.21827	1	0.03685	-0.05648	-0.14212	0.1096	0.19288
26.Driver with passengers	0.01959	-0.02761	0.03561	0.01362	-0.00553	-0.01434	-0.02688	0.01189	-0.00455	0.03685	1	0.06252	0.01143	-0.00542	0.00353
27.Female driver	0.10151	0.00462	-0.0083	-0.01159	0.02143	-0.01479	-0.00067	0.03045	0.00669	-0.05648	0.06252	1	0.08009	-0.03618	-0.0066
28.Driver safety belt used	0.00819	-0.01403	0.01713	-0.00609	0.0282	0.01374	0.08428	0.06756	-0.05008	-0.14212	0.01143	0.08009	1	-0.22171	-0.07228
29.Ejected	-0.00999	0.02345	-0.01915	-0.00461	-0.00693	-0.00954	-0.02756	-0.0394	0.00559	0.1096	-0.00542	-0.03618	-0.22171	1	-0.00599
30.Trapped	-0.00851	0.01455	-0.00672	-0.00521	-0.02157	-0.00983	-0.04299	-0.05134	-0.01487	0.19288	0.00353	-0.0066	-0.07228	-0.00599	1
31.Fatal injury/injury incapacitating	-0.02218	0.02217	-0.01305	-0.00264	-0.02156	-0.01416	-0.05613	-0.06862	-0.00654	0.22889	-0.00461	-0.01534	-0.15091	0.32192	0.3015
32.Injury not incapacitating /possible injury	-0.00438	0.06169	-0.0317	0.00014	-0.06572	-0.04822	-0.17691	-0.16889	0.1743	0.2862	0.00166	0.01394	-0.16302	0.07715	0.07997
33.Not injured	0.00781	-0.06188	0.03228	-0.00105	0.07221	0.04976	0.18201	0.1782	-0.15511	-0.33635	-0.00083	0.00158	0.27283	-0.17076	-0.16371
34.Teen passengers	-0.01088	-0.02075	0.01405	0.02347	-0.00151	-0.0076	-0.01294	0.00398	0.00036	0.01961	0.35909	-0.06438	0.00056	-0.00134	-0.00851
35.Speed limit<35 mph	0.02053	-0.04664	0.07008	-0.04431	-0.00032	0.02184	0.06246	0.06425	-0.08237	-0.07336	0.0243	0.00795	-0.02858	-0.00485	-0.03593
36.Speed limit_35-60 mph	0.00166	0.05225	-0.04856	-0.0373	0.01116	-0.00118	0.00318	-0.01036	0.0183	-0.0181	-0.02623	0.02345	0.03674	-0.01107	-0.01142
37.Speed limit>60 mph	-0.02864	-0.00823	-0.02374	0.11268	-0.02271	-0.03271	-0.09275	-0.06931	0.08594	0.12871	0.00892	-0.04015	-0.01842	0.02519	0.06636
38.Concrete road surface type	-0.00276	0.00805	0.00572	0.00065	-0.01555	-0.00243	0.00641	0.00637	0.01116	-0.03404	0.00111	-0.00959	0.04198	-0.01189	-0.02468
39.Black top road surface	-0.00232	-0.0096	0.00028	-0.01133	0.01791	-0.00024	0.01194	0.00392	-0.01859	0.00347	-0.01036	0.02529	-0.00827	-0.00533	0.02269
40.Gravel/brick road surface type	0.0133	0.0041	-0.01555	0.02763	-0.00589	0.00711	-0.0452	-0.02533	0.02231	0.07165	0.02235	-0.04083	-0.07935	0.04263	0.00334
41.Wet/debris road surface condition	-0.00382	-0.01317	0.00401	-0.00363	0.02003	-0.00918	-0.01899	0.03696	-0.0022	-0.02826	0.02006	-0.01178	0.01632	-0.00466	-0.02005
42.Curved road	-0.01505	-0.00933	0.01559	0.01642	-0.02115	-0.02616	-0.04231	-0.04263	0.0294	0.09675	0.0141	-0.03389	-0.04324	0.0433	0.00661
43.Work_zone_realeted	0.00157	-0.00369	-0.0194	0.00141	0.03936	-0.01156	-0.00328	0.00971	0.00997	-0.01976	0.0137	-0.00715	0.01599	-0.00784	-0.00214
44.Multi lanes road	-0.00793	0.03546	-0.02406	0.01455	-0.03705	-0.03644	-0.01378	-0.01336	0.01945	0.02187	0.00723	0.01895	0.0131	0.00138	0.00221
45.5.00-9.00-Morning	-0.00214	0.00055	0.00547	-0.00846	0.00181	-0.01102	-0.02085	0.00128	0.01828	0.00976	-0.07591	-0.00299	0.02365	-0.01504	0.0095
46.9.00-13.00-Noon	0.00492	-0.01131	0.00923	-0.00975	0.01724	0.01126	0.0283	0.02876	-0.03526	-0.03792	-0.00831	0.05063	0.04743	-0.01121	-0.01006
47.13.00-17.00-Afternoon	-0.00102	-0.01112	0.00603	-0.00499	0.0264	0.01809	0.06651	0.04037	-0.0608	-0.07425	0.02344	0.0333	0.05555	-0.01901	-0.00639
48.17.00-21.00-Evening	0.01312	-0.00796	-0.00453	0.02269	0.0077	0.0079	0.02211	0.01573	-0.01349	-0.03827	0.02311	0.01103	0.0145	-0.00401	-0.03128
49.21.00-5.00-Night	-0.01792	0.03584	-0.01804	-0.00079	-0.06412	-0.03415	-0.12256	-0.10557	0.11684	0.1732	0.02745	-0.1102	-0.1659	0.05769	0.04748
50.Week end	-0.00839	0.01573	-0.0103	-0.00521	-0.02913	-0.01508	-0.05419	-0.04431	0.04372	0.08678	0.09444	-0.04443	-0.06646	0.02149	0.02112
51.On roadway	-0.01514	0.00519	-0.01571	0.01276	0.01239	-0.00337	-0.00493	0.01608	0.00454	-0.01789	-0.01736	0.00564	0.00692	-0.00418	-0.01714
52.At Intersection	0.02613	-0.03948	0.05142	-0.05332	0.05011	0.03593	0.12377	0.076	-0.11269	-0.14411	0.00538	0.0544	0.09361	-0.04502	-0.03701
53.Off roadway crash	-0.01892	0.04848	-0.05097	0.05832	-0.08711	-0.04745	-0.16781	-0.12961	0.1532	0.22833	0.01551	-0.08275	-0.1337	0.06997	0.07582
54.Dark	-0.00752	0.02446	-0.01877	0.00891	-0.04788	-0.02989	-0.10336	-0.09575	0.10548	0.14966	0.02812	-0.10013	-0.12118	0.03435	0.03327
55.Adverse weather conditions	-0.00509	-0.00582	-0.00012	-0.00945	0.01315	-0.00374	-0.02869	0.02521	0.00901	-0.01397	0.01559	-0.02121	0.01511	-0.01281	-0.01003
56.Rural roads	-0.01723	0.03355	-0.04126	0.05874	-0.04457	-0.03025	-0.12829	-0.09021	0.08841	0.21524	0.0302	-0.0615	-0.1024	0.07484	0.06435
57.Animal factors	0.00001	-0.0071	0.00277	0.03217	-0.00768	-0.00496	-0.0228	-0.00534	0.02737	0.00335	-0.00518	-0.0162	0.01551	-0.00398	-0.00458
58.Weather factors	-0.00595	0.00085	-0.01086	0.0159	0.00076	-0.0039	-0.01231	-0.00852	0.0121	0.01379	0.00698	-0.00499	0.0092	-0.00716	-0.00738
59.Vision obstruction factors	-0.00425	0.00052	-0.01528	0.00846	0.01633	-0.00491	-0.00502	-0.00547	-0.00145	0.01515	0.00735	-0.00678	-0.00381	-0.00299	-0.00308
60.Vehicle factors	-0.02416	-0.00621	0.00271	-0.00647	0.00682	-0.01047	-0.01481	-0.00722	0.0235	0.001	0.00608	-0.01704	0.00729	-0.00637	-0.00657
61.Road factors	-0.00262	-0.01205	-0.01622	0.0134	0.03038	-0.00393	-0.0098	-0.01406	0.02249	-0.00004	0.00701	-0.01606	0.01007	-0.00804	0.0039

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.2 (continued)

Variable	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1.Cell phone	0.04341	0.04623	-0.05275	-0.03048	-0.01452	0.01656	-0.00067	-0.00681	0.00451	0.00625	-0.02025	0.01558	-0.00608	0.00385	-0.01765
2.Other electronic devices	-0.00249	0.00923	-0.00264	-0.01733	-0.03243	0.02576	0.00215	-0.01074	0.0149	-0.0107	-0.01175	-0.01081	0.00179	0.00976	-0.01401
3.In/on vehicle distraction	-0.00106	0.01835	-0.0166	-0.00373	-0.00762	0.00302	0.00379	-0.01378	0.02174	-0.01947	-0.03278	-0.01459	-0.01498	0.0169	-0.02757
4.External distraction	-0.02027	-0.02567	0.0355	-0.01393	-0.01633	0.03958	-0.03343	0.02877	-0.02695	-0.00412	-0.02445	-0.02036	0.00896	0.01115	-0.00459
5.Inattention	-0.04781	-0.09261	0.09282	0.02999	0.08431	0.01212	-0.12658	0.01079	-0.01132	0.00269	0.06344	-0.02275	0.01616	-0.02686	-0.0361
6.Valid licensed	-0.00739	-0.0346	0.05597	-0.0249	-0.04261	0.02364	0.02267	-0.01894	0.0211	-0.00091	-0.01131	-0.01269	0.03546	0.01834	0.00562
7.Restricted license	0.00442	-0.00811	0.01448	-0.01064	-0.03069	0.00477	0.03552	0.00794	-0.00711	0.0004	-0.00697	-0.01151	0.01535	0.01538	-0.00171
8.Alcohol/drug related	0.12188	0.10468	-0.13187	0.00431	-0.00008	-0.00887	0.01244	-0.02363	-0.00079	0.05836	-0.00555	0.04525	-0.01333	0.01796	-0.04015
9.Vehicle age (Year 5 or newer)	-0.00689	-0.00467	0.00872	-0.00358	-0.01881	0.00584	0.01977	-0.01011	0.00682	0.00879	-0.02177	-0.00104	0.00036	0.00941	0.00789
10.Vehicle age (6-10 years)	-0.00916	-0.02377	0.03089	-0.02283	-0.00413	-0.01593	0.02944	-0.00205	0.00857	-0.01878	-0.02154	0.0098	0.00771	-0.01081	0.03123
11.Vehicle age (11-15 years)	0.00447	-0.01059	0.00984	0.00359	-0.00725	0.00209	0.00537	0.01251	-0.0063	-0.0122	0.00274	0.00334	0.01656	0.01146	-0.00834
12.Vehicle age (Year 16 or older)	0.00453	0.03327	-0.03812	0.01898	0.01917	0.01003	-0.04101	-0.00663	-0.00333	0.02329	0.02819	-0.01296	-0.02447	-0.00636	-0.02366
13.Automobile	-0.01362	0.01073	-0.00336	0.01038	-0.01427	0.00931	0.00759	0.00216	0.02591	-0.06975	0.00208	0.00171	0.00482	0.01945	-0.00252
14.Van	0.0006	0.00219	-0.00779	-0.01079	0.01042	-0.01064	-0.00145	0.0159	-0.01024	-0.01209	-0.00308	-0.00526	-0.00469	-0.00419	0.0085
15.Pickup truck camper-rv	0.03558	-0.00946	0.00087	0.00276	-0.00753	-0.00758	0.01985	-0.00807	-0.02577	0.08241	0.00217	0.01516	-0.00655	-0.01612	0.00005
16.Sport utility vehicle	-0.02218	-0.00438	0.00781	-0.01088	0.02053	0.00166	-0.02864	-0.00276	-0.00232	0.0133	-0.00382	-0.01505	0.00157	-0.00793	-0.00214
17.Straight following	0.02217	0.06169	-0.06188	-0.02075	-0.04664	0.05225	-0.00823	0.00805	-0.0096	0.0041	-0.01317	-0.00933	-0.00369	0.03546	0.00055
18.Turn/changing lanes maneuver	-0.01305	-0.0317	0.03228	0.01405	0.07008	-0.04856	-0.02374	0.00572	0.00028	-0.01555	0.00401	0.01559	-0.0194	-0.02406	0.00547
19.Avoiding maneuver	-0.00264	0.00014	-0.00105	0.02347	-0.04431	-0.0373	0.11268	0.00065	-0.01133	0.02763	-0.00363	0.01642	0.00141	0.01455	-0.00846
20.Stopped/parking/backing maneuver	-0.02156	-0.06572	0.07221	-0.00151	-0.00032	0.01116	-0.02271	-0.01555	0.01791	-0.00589	0.02003	-0.02115	0.03936	-0.03705	0.00181
21.No damage	-0.01416	-0.04822	0.04976	-0.0076	0.02184	-0.00118	-0.03271	-0.00243	-0.00024	0.00711	-0.00918	-0.02616	-0.01156	-0.03644	-0.01102
22.Minor damage	-0.05613	-0.17691	0.18201	-0.01294	0.06246	0.00318	-0.09275	0.00641	0.01194	-0.0452	-0.01899	-0.04231	-0.00328	-0.01378	-0.02085
23.Functional damage	-0.06862	-0.16889	0.1782	0.00398	0.06425	-0.01036	-0.06931	0.00637	0.00392	-0.02533	0.03696	-0.04263	0.00971	-0.01336	0.00128
24.Disabling damage	-0.00654	0.1743	-0.15511	0.00036	-0.08237	0.0183	0.08594	0.01116	-0.01859	0.02231	-0.0022	0.0294	0.00997	0.01945	0.01828
25.Destroyed damage	0.22889	0.2862	-0.33635	0.01961	-0.07336	-0.0181	0.12871	-0.03404	0.00347	0.07165	-0.02826	0.09675	-0.01976	0.02187	0.00976
26.Driver with passengers	-0.00461	0.00166	-0.00083	0.35909	0.0243	-0.02623	0.00892	0.00111	-0.01036	0.02235	0.02006	0.0141	0.0137	0.00723	-0.07591
27.Female driver	-0.01534	0.01394	0.00158	-0.06438	0.00795	0.02345	-0.04015	-0.00959	0.02529	-0.04083	-0.01178	-0.03389	-0.00715	0.01895	-0.00299
28.Driver safety belt used	-0.15091	-0.16302	0.27283	0.00056	-0.02858	0.03674	-0.01842	0.04198	-0.00827	-0.07935	0.01632	-0.04324	0.01599	0.0131	0.02365
29.Ejected	0.32192	0.07715	-0.17076	-0.00134	-0.00485	-0.01107	0.02519	-0.01189	-0.00533	0.04263	-0.00466	0.0433	-0.00784	0.00138	-0.01504
30.Trapped	0.3015	0.07997	-0.16371	-0.00851	-0.03593	-0.01142	0.06636	-0.02468	0.02269	0.00334	-0.02005	0.00661	-0.00214	0.00221	0.0095
31.Fatal injury/injury incapacitating	1	-0.04357	-0.26318	-0.00808	-0.04144	-0.02297	0.08916	-0.03123	0.0202	0.02568	-0.02448	0.04102	0.00083	0.0037	0.01875
32.Injury not incapacitating /possible injury	-0.04357	1	-0.89626	-0.01084	-0.0665	0.00219	0.08659	-0.03415	0.00957	0.05646	-0.02163	0.05477	-0.00328	0.01838	0.00964
33.Not injured	-0.26318	-0.89626	1	0.00757	0.06118	0.01118	-0.10006	0.04348	-0.01663	-0.06058	0.027	-0.06373	0.00191	-0.01322	-0.0132
34.Teen passengers	-0.00808	-0.01084	0.00757	1	0.01612	-0.00746	-0.00885	0.00262	-0.00869	0.01637	0.01673	0.00619	-0.0085	0.00054	-0.04123
35.Speed limit<35 mph	-0.04144	-0.0665	0.06118	0.01612	1	-0.71812	-0.24703	-0.07222	0.06833	0.0025	0.01972	-0.0462	-0.05094	-0.04775	-0.05301
36.Speed limit_35-60 mph	-0.02297	0.00219	0.01118	-0.00746	-0.71812	1	-0.45955	0.00272	-0.01971	0.04361	-0.0285	-0.03416	0.02813	0.07591	-0.02342
37.Speed limit>60 mph	0.08916	0.08659	-0.10006	-0.00885	-0.24703	-0.45955	1	0.09095	-0.05932	-0.0714	0.01675	0.10337	0.02307	-0.01254	0.10629
38.Concrete road surface type	-0.03123	-0.03415	0.04348	0.00262	-0.07222	0.00272	0.09095	1	-0.91662	-0.12368	-0.01237	-0.00373	0.05863	-0.02082	0.03489
39.Black top road surface	0.0202	0.00957	-0.01663	-0.00869	0.06833	-0.01971	-0.05932	-0.91662	1	-0.2782	0.00818	-0.01062	-0.04495	0.05363	-0.02999
40.Gravel/brick road surface type	0.02568	0.05646	-0.06058	0.01637	0.0025	0.04361	-0.0714	-0.12368	-0.2782	1	0.01136	0.03537	-0.0286	-0.07709	-0.01012
41.Wet/debris road surface condition	-0.02448	-0.02163	0.027	0.01673	0.01972	-0.0285	0.01675	-0.01237	0.00818	0.01136	1	0.00063	-0.02577	-0.00329	0.03742
42.Curved road	0.04102	0.05477	-0.06373	0.00619	-0.0462	-0.03416	0.10337	-0.00373	-0.01062	0.03537	0.00063	1	0.00816	-0.09337	0.03776
43.Work_zone_realeted	0.00083	-0.00328	0.00191	-0.0085	-0.05094	0.02813	0.02307	0.05863	-0.04495	-0.0286	-0.02577	0.00816	1	-0.0348	0.00491
44.Multi lanes road	0.0037	0.01838	-0.01322	0.00054	-0.04775	0.07591	-0.01254	-0.02082	0.05363	-0.07709	-0.00329	-0.09337	-0.0348	1	-0.02117
45.5.00-9.00-Morning	0.01875	0.00964	-0.0132	-0.04123	-0.05301	-0.02342	0.10629	0.03489	-0.02999	-0.01012	0.03742	0.03776	0.00491	-0.02117	1
46.9.00-13.00-Noon	-0.01768	-0.02176	0.02514	-0.01207	0.0324	0.00954	-0.04969	-0.00572	0.01236	-0.01486	0.00581	-0.02271	0.02796	0.01229	-0.19658
47.13.00-17.00-Afternoon	-0.01986	-0.04953	0.05631	0.01036	0.03706	0.01083	-0.06468	-0.0088	0.02239	-0.03591	-0.03913	-0.05879	-0.00764	-0.00787	-0.27444
48.17.00-21.00-Evening	-0.02614	-0.02341	0.03512	0.01778	-0.02838	0.03366	-0.01483	0.0127	0.0004	-0.03038	-0.02322	-0.03413	-0.00446	0.02154	-0.22484
49.21.00-5.00-Night	0.05814	0.10607	-0.1294	0.0209	0.00382	-0.04188	0.0498	-0.03402	-0.01154	0.10943	0.03345	0.10368	-0.02001	-0.00794	-0.16972
50.Week end	0.02779	0.04415	-0.05578	0.06238	-0.0092	-0.01852	0.03478	-0.03742	0.01402	0.05598	0.0262	0.03137	-0.03202	0.01948	-0.08685
51.On roadway	-0.01409	-0.01777	0.02359	-0.0034	0.0221	-0.00217	-0.02192	-0.00043	0.00312	-0.00448	-0.01174	-0.06357	0.04567	0.01007	-0.00757
52.At Intersection	-0.06004	-0.09423	0.10738	-0.0071	0.02954	0.07167	-0.13674	0.05288	0.00224	-0.13476	-0.00919	-0.07587	-0.01849	0.01157	-0.01705
53.Off roadway crash	0.1047	0.15954	-0.18563	0.01616	-0.07848	-0.09406	0.22615	-0.07064	-0.0061	0.18477	0.025	0.18676	-0.0328	-0.01874	0.03484
54.Dark	0.04092	0.07822	-0.09632	0.02615	-0.02593	-0.01829	0.05308	-0.03031	-0.00579	0.08877	0.05649	0.09088	-0.03591	0.00132	-0.11871
55.Adverse weather conditions	-0.02056	-0.01297	0.01753	0.01528	0.0034	-0.02219	0.02931	-0.0012	0.00877	-0.02079	0.78233	0.00144	-0.02981	-0.00339	0.01581
56.Rural roads	0.09072	0.14925	-0.164	0.01412	-0.15375	-0.00673	0.21614	-0.14781	0.02307	0.30322	0.01377	0.09887	-0.03623	-0.01255	0.02758
57.Animal factors	-0.00691	0.01291	-0.00379	0.01306	-0.01286	-0.01114	0.03357	-0.01779	0.01046	0.01771	0.2196	0.02211	-0.01297	-0.00971	0.04238
58.Weather factors	-0.00195	0.0129	-0.01035	-0.00182	0.00645	-0.04204	0.05293	0.01904	-0.02338	0.01292	0.15097	0.01152	-0.01773	-0.00344	0.00987
59.Vision obstruction factors	-0.00443	-0.00822	0.01049	0.00523	0.01165	-0.01268	0.00456	0.00548	-0.0022	-0.00759	0.074	0.01391	-0.00739	-0.01783	0.0096
60.Vehicle factors	-0.00946	0.00341	0.00001	0.00206	-0.00108	-0.00447	0.00788	0.01367	-0.01124	-0.00457	0.01291	-0.00068	0.01403	-0.01391	0.02013
61.Road factors	-0.01275	0.00274	-0.00475	0.00438	-0.04497	-0.00684	0.07297	0.01588	-0.02018	0.01305	0.32353	0.02516	0.07453	0.00378	0.04626

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.2 (continued)

Variable	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
1.Cell phone	-0.02439	-0.03184	-0.01809	0.109	0.02714	-0.03491	-0.00536	0.05318	0.08322	-0.01101	0.01711	-0.01842	-0.01523	0.00299	-0.00712	-0.01399
2.Other electronic devices	0.00266	-0.0127	0.02701	-0.00594	0.02509	0.00404	0.00201	-0.0071	0.00844	-0.01022	0.00276	0.00241	-0.00495	0.01259	-0.01105	0.0051
3.In/on vehicle distraction	0.00374	0.01789	0.03014	-0.03564	-0.00457	-0.0087	-0.00138	0.01468	-0.02122	-0.03726	0.01825	-0.02712	-0.02225	-0.01327	0.00386	-0.00793
4.External distraction	0.01794	0.00995	0.01038	-0.04017	-0.00858	0.0097	0.0098	-0.02671	-0.03145	-0.01285	-0.03525	0.01328	-0.00011	0.00625	-0.01499	-0.00022
5.Inattention	0.03609	0.0564	0.02151	-0.1028	-0.06627	0.04506	0.09918	-0.19999	-0.09786	0.04888	-0.1273	0.03172	0.03104	0.0073	0.01455	0.02029
6.Valid licensed	0.03166	0.00725	0.0126	-0.06538	-0.04237	0.01121	0.01808	-0.03683	-0.06346	-0.01294	0.0274	0.01198	0.00156	-0.0086	-0.00931	-0.00631
7.Restricted license	0.02716	0.00416	0.00796	-0.04402	-0.02718	-0.00459	0.0149	-0.01452	-0.03056	-0.00013	0.01226	-0.00276	0.00429	0.00227	-0.01389	-0.00791
8.Alcohol/drug related	-0.0931	-0.12492	-0.05424	0.37122	0.15534	-0.03004	-0.12399	0.20831	0.29537	-0.00025	0.08855	-0.02055	-0.00909	-0.00923	-0.01969	-0.01843
9.Vehicle age (Year 5 or newer)	-0.0009	-0.01916	0.01237	0.00409	-0.00887	-0.03186	0.00407	0.03493	0.02593	-0.01068	0.02217	-0.01384	0.02577	-0.00213	-0.01094	0.00506
10.Vehicle age (6-10 years)	0.0176	-0.02531	-0.00956	-0.00516	0.02178	-0.00693	0.0055	0.00077	0.00186	-0.0183	-0.01083	-0.00035	-0.01074	0.01356	-0.01941	-0.00856
11.Vehicle age (11-15 years)	-0.0002	0.00524	0.00056	-0.00032	-0.01258	0.01161	-0.00916	-0.00137	-0.00415	0.00092	0.00958	-0.00188	0.00588	-0.0129	-0.01273	0.00461
12.Vehicle age (Year 16 or older)	-0.01563	0.02789	0.00024	0.00427	-0.00156	0.01134	0.00175	-0.01671	-0.01027	0.0219	-0.0109	0.00941	-0.0098	0.00252	0.03288	-0.00167
13.Automobile	-0.01751	-0.00256	0.01792	0.00524	0.00687	0.02303	-0.00302	-0.02483	0.00958	-0.00139	-0.08764	-0.00065	-0.01376	-0.01055	0.00778	-0.00722
14.Van	0.01742	0.02068	-0.0133	-0.04031	-0.01226	-0.0012	0.00388	-0.00561	-0.03487	-0.01049	-0.02355	-0.01171	0.00185	-0.00661	-0.00088	0.00375
15.Pickup truck camper-rv	0.00954	-0.00463	-0.0295	0.02978	0.00479	-0.01603	-0.02279	0.05438	0.0108	0.01178	0.14221	0.00659	0.02336	0.02111	0.01467	0.00957
16.Sport utility vehicle	0.00492	-0.00102	0.01312	-0.01792	-0.00839	-0.01514	0.02613	-0.01892	-0.00752	-0.00509	-0.01723	0.00001	-0.00595	-0.00425	-0.02416	-0.00262
17.Straight following	-0.01131	-0.01112	-0.00796	0.03584	0.01573	0.00519	-0.03948	0.04848	0.02446	-0.00582	0.03355	-0.0071	0.00085	0.00052	-0.00621	-0.01205
18.Turn/changing lanes maneuver	0.00923	0.00603	-0.00453	-0.01804	-0.0103	-0.01571	0.05142	-0.05097	-0.01877	-0.00012	-0.04126	0.00277	-0.01086	-0.01528	0.00271	-0.01622
19.Avoiding maneuver	-0.00975	-0.00499	0.02269	-0.00079	-0.00521	0.01276	-0.05332	0.05832	0.00891	-0.00945	0.05874	0.03217	0.0159	0.00846	-0.00647	0.0134
20.Stopped/parking/backing maneuver	0.01724	0.0264	0.0077	-0.06412	-0.02913	0.01239	0.05011	-0.08711	-0.04788	0.01315	-0.04457	-0.00768	0.00076	0.01633	0.00682	0.03038
21.No damage	0.01126	0.01809	0.0079	-0.03415	-0.01508	-0.00337	0.03593	-0.04745	-0.02989	-0.00374	-0.03025	-0.00496	-0.0039	-0.00491	-0.01047	-0.00393
22.Minor damage	0.0283	0.06651	0.02211	-0.12256	-0.05419	-0.00493	0.12377	-0.16781	-0.10336	-0.02869	-0.12829	-0.0228	-0.01231	-0.00502	-0.01481	-0.0098
23.Functional damage	0.02876	0.04037	0.01573	-0.10557	-0.04431	0.01608	0.076	-0.12961	-0.09575	0.02521	-0.09021	-0.00534	-0.00852	-0.00547	-0.00722	-0.01406
24.Disabling damage	-0.03526	-0.0608	-0.01349	0.11684	0.04372	0.00454	-0.11269	0.1532	0.10548	0.00901	0.08841	0.02737	0.0121	-0.00145	0.0235	0.02249
25.Destroyed damage	-0.03792	-0.07425	-0.03827	0.1732	0.08678	-0.01789	-0.14411	0.22833	0.14966	-0.01397	0.21524	0.00335	0.01379	0.01515	0.001	-0.00004
26.Driver with passengers	-0.00831	0.02344	0.02311	0.02745	0.09444	-0.01736	0.00538	0.01551	0.02812	0.01559	0.0302	-0.00518	0.00698	0.00735	0.00608	0.00701
27.Female driver	0.05063	0.0333	0.01103	-0.1102	-0.04443	0.00564	0.0544	-0.08275	-0.10013	-0.02121	-0.0615	-0.0162	-0.00499	-0.00678	-0.01704	-0.01606
28.Driver safety belt used	0.04743	0.05555	0.0145	-0.1659	-0.06646	0.00692	0.09361	-0.1337	-0.12118	0.01511	-0.1024	0.01551	0.0092	-0.00381	0.00729	0.01007
29.Ejected	-0.01121	-0.01901	-0.00401	0.05769	0.02149	-0.00418	-0.04502	0.06997	0.03435	-0.01281	0.07484	-0.00398	-0.00716	-0.00299	-0.00637	-0.00804
30.Trapped	-0.01006	-0.00639	-0.03128	0.04748	0.02112	-0.01714	-0.03701	0.07582	0.03327	-0.01003	0.06435	-0.00458	-0.00738	-0.00308	-0.00657	0.0039
31.Fatal injury/injury incapacitating	-0.01768	-0.01986	-0.02614	0.05814	0.02779	-0.01409	-0.06004	0.1047	0.04092	-0.02056	0.09072	-0.00691	-0.00195	-0.00443	-0.00946	-0.01275
32.Injury not incapacitating /possible injury	-0.02176	-0.04953	-0.02341	0.10607	0.04415	-0.01777	-0.09423	0.15954	0.07822	-0.01297	0.14925	0.01291	0.0129	-0.00822	0.00341	0.00274
33.Not injured	0.02514	0.05631	0.03512	-0.1294	-0.05578	0.02359	0.10738	-0.18563	-0.09632	0.01753	-0.164	-0.00379	-0.01035	0.01049	0.00001	-0.00475
34.Teen passengers	-0.01207	0.01036	0.01778	0.0209	0.06238	-0.0034	-0.0071	0.01616	0.02615	0.01528	0.01412	0.01306	-0.00182	0.00523	0.00206	0.00438
35.Speed limit<35 mph	0.0324	0.03706	-0.02838	0.00382	-0.0092	0.0221	0.02954	-0.07848	-0.02593	0.0034	-0.15375	-0.01286	0.00645	0.01165	-0.00108	-0.04497
36.Speed limit_35-60 mph	0.00954	0.01083	0.03366	-0.04188	-0.01852	-0.00217	0.07167	-0.09406	-0.01829	-0.02219	-0.00673	-0.01114	-0.04204	-0.01268	-0.00447	-0.00684
37.Speed limit>60 mph	-0.04969	-0.06468	-0.01483	0.0498	0.03478	-0.02192	-0.13674	0.22615	0.05308	0.02931	0.21614	0.03357	0.05293	0.00456	0.00788	0.07297
38.Concrete road surface type	-0.00572	-0.0088	0.0127	-0.03402	-0.03742	-0.00043	0.05288	-0.07064	-0.03031	-0.0012	-0.14781	-0.01779	0.01904	0.00548	0.01367	0.01588
39.Black top road surface	0.01236	0.02239	0.0004	-0.01154	0.01402	0.00312	0.00224	-0.0061	-0.00579	0.00877	0.02307	0.01046	-0.02338	-0.0022	-0.01124	-0.02018
40.Gravel/brick road surface type	-0.01486	-0.03591	-0.03038	0.10943	0.05598	-0.00448	-0.13476	0.18477	0.08877	-0.02079	0.30322	0.01771	0.01292	-0.00759	-0.00457	0.01305
41.Wet/debris road surface condition	0.00581	-0.03913	-0.02322	0.03345	0.0262	-0.01174	-0.00919	0.025	0.05649	0.78233	0.01377	0.2196	0.15097	0.074	0.01291	0.32353
42.Curved road	-0.02271	-0.05879	-0.03413	0.10368	0.03137	-0.06357	-0.07587	0.18676	0.09088	0.00144	0.09887	0.02211	0.01152	0.01391	-0.00068	0.02516
43.Work_zone_realeted	0.02796	-0.00764	-0.00446	-0.02001	-0.03202	0.04567	-0.01849	-0.0328	-0.03591	-0.02981	-0.03623	-0.01297	-0.01773	-0.00739	0.01403	0.07453
44.Multi lanes road	0.01229	-0.00787	0.02154	-0.00794	0.01948	0.01007	0.01157	-0.01874	0.00132	-0.00339	-0.01255	-0.00971	-0.00344	-0.01783	-0.01391	0.00378
45.5.00-9.00-Morning	-0.19658	-0.27444	-0.22484	-0.16972	-0.08685	-0.00757	-0.01705	0.03484	-0.11871	0.01581	0.02758	0.04238	0.00987	0.0096	0.02013	0.04626
46.9.00-13.00-Noon	1	-0.31	-0.25397	-0.19171	-0.00045	-0.0058	0.05256	-0.0661	-0.26914	0.00046	-0.04286	-0.02071	0.01099	0.01143	0.01693	0.00573
47.13.00-17.00-Afternoon	-0.31	1	-0.35457	-0.26764	-0.04702	0.02696	0.07012	-0.13122	-0.35696	-0.03872	-0.0647	-0.03348	-0.00696	-0.00068	-0.01481	-0.01625
48.17.00-21.00-Evening	-0.25397	-0.35457	1	-0.21927	-0.04672	0.01399	0.04266	-0.07934	0.17738	-0.01087	-0.04469	0.01175	-0.01585	-0.00456	-0.00347	-0.02155
49.21.00-5.00-Night	-0.19171	-0.26764	-0.21927	1	0.20558	-0.03687	-0.18383	0.30322	0.67344	0.04731	0.15484	0.01012	0.00618	-0.01594	-0.01536	-0.00858
50.Week end	-0.00045	-0.04702	-0.04672	0.20558	1	-0.03107	-0.08156	0.15213	0.16479	0.0295	0.0851	0.00151	0.01412	0.0064	-0.0088	0.01101
51.On roadway	-0.0058	0.02696	0.01399	-0.03687	-0.03107	1	-0.73159	-0.28444	-0.028	-0.00857	-0.03121	-0.01169	-0.0151	-0.00238	-0.00426	-0.02535
52.At Intersection	0.05256	0.07012	0.04266	-0.18383	-0.08156	-0.73159	1	-0.43708	-0.15299	-0.01486	-0.23966	-0.01207	-0.01424	-0.00922	0.00707	-0.02
53.Off roadway crash	-0.0661	-0.13122	-0.07934	0.30322	0.15213	-0.28444	-0.43708	1	0.24885	0.03171	0.37435	0.03392	0.03824	0.01656	-0.00365	0.06358
54.Dark	-0.26914	-0.35696	0.17738	0.67344	0.16479	-0.028	-0.15299	0.24885	1	0.07189	0.132	0.01922	0.00918	-0.01245	-0.01178	-0.005
55.Adverse weather conditions	0.00046	-0.03872	-0.01087	0.04731	0.0295	-0.00857	-0.01486	0.03171	0.07189	1	0.02256	0.2736	0.19561	0.09648	0.01312	0.25854
56.Rural roads	-0.04286	-0.0647	-0.04469	0.15484	0.0851	-0.03121	-0.23966	0.37435	0.132	0.02256	1	0.05709	0.04663	0.00731	0.01234	0.04569
57.Animal factors	-0.02071	-0.03348	0.01175	0.01012	0.00151	-0.01169	-0.01207	0.03392	0.01922	0.2736	0.05709	1	-0.01459	-0.00609	0.00134	0.20027
58.Weather factors	0.01099	-0.00696	-0.01585	0.00618	0.01412	-0.0151	-0.01424	0.03824	0.00918	0.19561	0.04663	-0.01459	1	-0.00368	-0.00786	0.18765
59.Vision obstruction factors	0.01143	-0.00068	-0.00456	-0.01594	0.0064	-0.00238	-0.00922	0.01656	-0.01245	0.09648	0.00731	-0.00609	-0.00368	1	-0.00328	0.11797
60.Vehicle factors	0.01693	-0.01481	-0.00347	-0.01536	-0.0088	-0.00426	0.00707	-0.00365	-0.01178	0.01312	0.01234	0.00134	-0.00786	-0.00328	1	0.02544
61.Road factors	0.00573	-0.01625	-0.02155	-0.00858	0.01101	-0.02535	-0.02	0.06358	-0.005	0.25854	0.04569	0.20027	0.18765	0.11797	0.02544	1

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.3 Collinearity Matrix for Injury Severity Model of Teenage Drivers and their Passengers

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.Teenage distracted by cell phone	1.00000	-0.02125	-0.04779	-0.02407	-0.18435	0.00237	0.00286	0.04837	0.00893	0.01799	-0.00442	-0.01113	0.00998	-0.01445	0.00091	-0.00597	0.04356
2.Teenage distracted by other electronic devices	-0.02125	1.00000	-0.03528	-0.01777	-0.13608	0.01328	-0.00371	-0.00504	0.00097	0.00822	0.00310	-0.00828	0.01086	-0.00304	-0.01825	0.00714	0.04183
3.Teenage distracted In/on-vehicle	-0.04779	-0.03528	1.00000	-0.03995	-0.30599	0.01820	-0.00162	-0.01979	0.00143	0.00557	-0.01072	0.00568	0.01502	-0.00371	-0.01400	-0.00278	0.07288
4.External distraction teenage	-0.02407	-0.01777	-0.03995	1.00000	-0.15410	0.01576	0.01349	-0.01132	-0.00487	-0.00689	-0.00104	0.00774	0.00756	-0.00477	0.00485	-0.01432	0.01318
5.Inattentive teenage	-0.18435	-0.13608	-0.30599	-0.15410	1.00000	0.03991	0.00397	-0.04873	0.00027	-0.00002	0.00098	-0.00238	0.00228	-0.02999	0.00483	0.00113	-0.07261
6.Valid licensed	0.00237	0.01328	0.01820	0.01576	0.03991	1.00000	-0.02012	-0.03719	0.01591	0.03063	0.00863	-0.03527	0.01791	-0.02461	0.01149	-0.02046	0.03435
7.Restricted license	0.00286	-0.00371	-0.00162	0.01349	0.00397	-0.02012	1.00000	-0.02139	0.01413	0.00258	0.00764	-0.01255	0.00810	0.01394	-0.01348	-0.00215	0.00110
8.Alchohol/drug related	0.04837	-0.00504	-0.01979	-0.01132	-0.04873	-0.03719	-0.02139	1.00000	-0.00044	-0.00105	0.00141	-0.00112	-0.01363	-0.00736	0.02125	0.00014	0.03484
9.Vehicle age (Year 5 or newer)	0.00893	0.00097	0.00143	-0.00487	0.00027	0.01591	0.01413	-0.00044	1.00000	-0.07553	-0.13069	-0.18363	0.04512	-0.02142	-0.04149	-0.01117	-0.02391
10.Vehicle age (6-10 years)	0.01799	0.00822	0.00557	-0.00689	-0.00002	0.03063	0.00258	-0.00105	-0.07553	1.00000	-0.28434	-0.39952	0.04239	-0.02110	-0.06215	0.01554	0.00060
11.Vehicle age (11-15 years)	-0.00442	0.00310	-0.01072	-0.00104	0.00098	0.00863	0.00764	0.00141	-0.13069	-0.28434	1.00000	-0.59131	-0.01592	0.03155	-0.06005	0.06669	-0.00087
12.Vehicle age (Year 16 or older)	-0.01113	-0.00828	0.00568	0.00774	-0.00238	-0.03527	-0.01255	-0.00112	-0.18363	-0.39952	-0.59131	1.00000	-0.02997	-0.00720	0.11585	-0.07118	0.00963
13.Automobile	0.00998	0.01086	0.01502	0.00756	0.00228	0.01791	0.00810	-0.01363	0.04512	0.04239	-0.01592	-0.02997	1.00000	-0.24094	-0.59603	-0.57972	0.02410
14.Van	-0.01445	-0.00304	-0.00371	-0.00477	-0.02999	-0.02461	0.01394	-0.00736	-0.02142	-0.02110	0.03155	-0.00720	-0.24094	1.00000	-0.07940	-0.07723	-0.01002
15.Pickup-truck, camper-rv	0.00091	-0.01825	-0.01400	0.00485	0.00483	0.01149	-0.01348	0.02125	-0.04149	-0.06215	-0.06005	0.11585	-0.59603	-0.07940	1.00000	-0.19105	-0.01896
16.Sport vehicle	-0.00597	0.00714	-0.00278	-0.01432	0.00113	-0.02046	-0.00215	0.00014	-0.01117	0.01554	0.06669	-0.07118	-0.57972	-0.07723	-0.19105	1.00000	-0.00770
17.Straight-following maneuver	0.04356	0.04183	0.07288	0.01318	-0.07261	0.03435	0.00110	0.03484	-0.02391	0.00060	-0.00087	0.00963	0.02410	-0.01002	-0.01896	-0.00770	1.00000
18.Turn/changing lanes maneuver	-0.03773	-0.03863	-0.07125	-0.00279	0.05401	-0.01899	0.01075	-0.03928	0.02462	-0.00893	0.00092	-0.00450	0.00402	0.00450	-0.01409	0.00680	-0.70960
19.Avoiding maneuver	-0.00242	0.00415	0.00382	0.00847	0.00277	-0.00542	-0.01422	0.01066	0.00185	0.00299	-0.00585	0.00257	-0.01364	0.00570	0.02054	-0.00761	-0.24870
20.Stopped/parking/backing maneuver	-0.03245	-0.02579	-0.02683	-0.01985	0.05579	-0.01343	-0.00391	-0.02097	0.01043	0.01395	0.00354	-0.01575	-0.03903	0.00353	0.03977	0.01124	-0.46349
21.No damage	-0.01860	-0.01141	0.00917	0.00417	0.00214	-0.00421	-0.00405	-0.01718	-0.01404	-0.01885	-0.01687	0.02841	-0.06080	-0.00902	0.06621	0.01577	-0.04389
22.Minor damage	-0.02920	-0.01982	-0.02959	-0.00193	0.07952	0.03183	-0.01429	-0.06097	0.00912	0.00242	-0.02328	0.01658	-0.09533	-0.01161	0.07139	0.05918	-0.12600
23.Functional damage	-0.01491	-0.00850	-0.02078	0.01469	0.05288	-0.00071	0.00916	-0.06858	0.00738	0.01213	0.00504	-0.01432	0.04820	0.00959	-0.04350	-0.02240	-0.05897
24.Disabling damage	0.03003	0.02659	0.02929	-0.00150	-0.06490	0.00192	0.00438	0.03553	0.00610	0.00948	0.01179	-0.01977	0.07710	0.00802	-0.06555	-0.03964	0.12261
25.Destroyed damage	0.02204	0.00574	0.02306	-0.01921	-0.09177	-0.03978	0.00028	0.14537	-0.02671	-0.03218	0.01746	0.01621	-0.03742	-0.00986	0.04197	0.01232	0.09681
26.Speed limit<35 mph	-0.01117	-0.02835	-0.00160	-0.02315	0.05047	-0.07613	-0.02164	0.00860	0.00325	-0.00625	-0.01560	0.01715	-0.00702	0.01346	-0.00344	0.00564	-0.10390
27.Speed limit 35-60 mph	0.00643	0.02165	0.00595	0.03815	0.00537	0.05622	0.01883	-0.01926	-0.01447	0.00360	-0.01254	0.01442	0.01131	-0.02187	-0.00208	-0.00172	0.09493
28.Speed limit>60 mph	0.00792	0.00653	-0.00344	-0.02793	-0.08643	0.02723	0.00802	0.01732	0.00965	0.00419	0.04153	-0.04452	-0.00374	0.01956	0.01287	-0.01615	0.02000
29.Concrete roads	-0.00981	-0.00569	-0.00876	0.02034	0.00315	0.00094	0.00171	-0.01932	-0.00312	-0.00089	0.01578	-0.01245	0.03626	-0.01044	-0.02527	-0.01768	-0.01892
30.Black top roads	0.01121	0.00818	0.00693	-0.00744	0.01848	0.02294	-0.00806	-0.02457	0.01469	0.01628	-0.00607	-0.01096	0.02339	0.01088	-0.04069	0.00456	-0.00412
31.Gravel/brick roads	-0.00396	-0.00461	0.00236	-0.02073	-0.03838	-0.04426	0.01224	0.07720	-0.02026	-0.02749	-0.01517	0.03969	-0.10234	-0.00595	0.11549	0.02261	0.03890
32.Wet/debris roads	-0.00718	-0.01588	-0.03023	-0.01279	0.03851	0.01116	-0.01280	0.00170	-0.00613	-0.02848	0.01317	0.01049	-0.00358	-0.01351	0.00650	0.00662	-0.00854
33.Curved road	0.01125	0.00345	0.00407	-0.01480	-0.04421	-0.01548	-0.00609	0.03692	0.03041	0.00702	-0.01879	0.00224	-0.00774	0.00989	0.01134	-0.00961	0.04801
34.Work zone related	-0.00873	0.00282	-0.00801	-0.00816	0.00739	0.00818	-0.00067	-0.00288	-0.00290	0.00499	0.00365	-0.00546	0.02119	0.00531	-0.02168	-0.00725	0.00550
35.Multi lanes road	-0.00583	0.00468	0.01080	0.00696	-0.01778	0.01401	-0.00066	-0.03232	0.00928	0.00911	-0.00681	-0.00217	0.01124	-0.01223	-0.00738	-0.00058	0.03120
36.5.00-9.00-morning	-0.01062	-0.00960	0.00664	-0.01044	0.02292	0.00674	0.03103	-0.01691	0.00055	-0.01219	0.00017	0.00830	-0.00826	0.00383	0.01142	-0.00103	0.02970
37.9.00-13.00-noon	-0.01247	0.00044	0.00329	-0.00060	0.04138	0.00330	-0.00761	-0.05114	-0.00894	0.00762	-0.00036	-0.00091	-0.01118	0.01785	0.00214	0.00353	-0.01894
38.13.00-17.00-afternoon	-0.02121	-0.00369	0.00496	0.00912	0.04128	0.01987	-0.00509	-0.08777	-0.01433	-0.00761	0.00314	0.00753	0.00416	0.00362	-0.01115	0.00317	0.00117
39.17.00-21.00-evening	0.00070	0.00230	0.00331	0.00931	-0.01882	0.01917	0.00639	-0.04594	0.00751	0.01792	-0.00253	-0.01264	0.00724	-0.00352	-0.01026	0.00240	-0.02232
40.21.00-5.00-night	0.05111	0.01051	-0.02025	-0.01256	-0.09747	-0.05913	-0.02188	0.24466	0.01973	-0.00742	-0.00092	-0.00214	0.00758	-0.02206	0.01116	-0.01026	0.01741
41.Weekend	0.01353	0.01409	0.00258	-0.00639	-0.08949	-0.03310	-0.02128	0.09690	0.00929	-0.00265	0.00165	-0.00274	-0.01799	-0.00570	0.03225	-0.00778	0.01840
42.Head On crash	-0.00919	-0.01414	0.00857	-0.00069	0.00324	0.00668	-0.00072	0.00288	-0.00198	-0.00493	-0.00999	0.01430	-0.00007	0.00348	-0.00267	0.00177	-0.07244
43.Rear end crash	-0.02763	0.01236	0.00931	0.06289	0.09618	0.10258	-0.00060	-0.10307	-0.01247	0.00590	0.01786	-0.01705	0.04084	-0.02154	-0.04993	0.01091	0.27113
44.Angle crash	-0.01839	-0.02570	-0.06080	-0.02760	0.05543	-0.01060	0.00465	-0.04128	0.00672	0.01630	-0.02003	0.00467	0.02255	0.00034	-0.01594	-0.01296	-0.21862
45.Opposite direction crash	-0.00650	0.00859	-0.00203	0.00710	-0.01481	-0.01508	0.00173	-0.00487	-0.00063	-0.01241	-0.00029	0.00741	-0.00681	0.00759	0.01737	-0.01222	-0.04222
46.Same direction crash	-0.01450	-0.01472	-0.03297	-0.01734	0.01206	0.00346	0.00187	-0.03673	0.01995	0.02190	-0.00083	-0.02227	0.00022	0.02502	-0.00705	-0.00459	-0.25441
47.Backed into crash	-0.01479	-0.01423	-0.02066	-0.00813	0.02882	-0.00212	0.00465	-0.01824	0.01583	0.01454	-0.00334	-0.01204	-0.03068	-0.00756	0.03357	0.01109	-0.16623
48.Single-vehicle crash	0.05209	0.02661	0.04601	-0.03791	-0.16119	-0.07209	-0.00911	0.13796	0.00924	-0.01645	0.00560	0.00428	-0.00776	0.00036	0.01958	-0.01100	0.09724
49.On roadway crash	-0.00823	-0.00178	-0.00911	0.00453	0.03640	-0.00088	-0.00870	-0.00878	-0.01799	-0.01199	-0.01170	0.02539	-0.00719	-0.00103	0.01134	-0.00369	-0.01890
50.At intersection crash	-0.02009	-0.01223	-0.02460	0.02502	0.07215	0.03261	0.00825	-0.07612	0.00887	0.01187	0.00627	-0.01843	0.04149	-0.00595	-0.04951	0.00095	-0.03715
51.Off roadway crash	0.03940	0.01891	0.04485	-0.03984	-0.14411	-0.03639	0.00200	0.10890	0.01318	-0.00030	0.00685	-0.00897	-0.04504	0.00807	0.05336	0.00099	0.07743
52.Dark	0.04768	0.00378	-0.01679	-0.01685	-0.09210	-0.04240	-0.00907	0.18472	0.02281	0.01063	0.00939	-0.02491	0.01683	-0.01829	0.00119	-0.01353	0.00946
53.Adverse conditions	-0.00328	-0.01644	-0.02548	-0.01504	0.02924	0.00964	-0.00811	-0.00041	-0.00883	-0.02583	0.01139	0.01109	0.00805	-0.01131	-0.00557	0.00204	-0.00460
54.Rural roads	0.00999	-0.00196	0.02203	-0.04145	-0.08639	0.00653	0.02234	0.07533	-0.00890	-0.02248	-0.00701	0.02731	-0.10326	0.01047	0.14110	-0.01201	0.02708
55.Animall factors	-0.02187	-0.01101	-0.01240	0.01060	0.01099	0.01415	0.00631	-0.00120	-0.00693	0.00576	0.01152	-0.01254	0.00129	0.00125	0.01526	-0.01682	-0.00195
56.Weatherl factors	-0.00846	-0.00151	-0.01385	0.00819	0.01205	0.00003	-0.00338	-0.00715	-0.00591	-0.01539	0.00258	0.01009	0.00004	-0.00977	0.00651	-0.00214	-0.01244
57.Vision obstruction	0.00521	-0.00517	-0.00005	0.00139	-0.00040	-0.00507	0.01112	-0.00663	-0.00769	-0.01385	-0.00326	0.01571	-0.00085	-0.00160	0.00345	-0.00118	0.00628
58.Vehicle factors	-0.00634	-0.01105	0.00969	-0.01251	0.00315	0.00019	-0.01029	-0.01113	0.00200	-0.02078	-0.01345	0.02690	0.01805	-0.01034	-0.01477	-0.00280	0.00905
59.Road factors	-0.01748	-0.00209	-0.01167	-0.00450	0.00510	0.01526	-0.00687	0.00808	0.00431	-0.01428	0.01788	-0.00869	-0.00235	0.00069	0.00321	-0.00146	0.00468
60.Passenger	-0.10635	-0.07851	-0.17653	-0.08891	-0.58096	-0.07187	-0.00939	0.02792	-0.00815	-0.00999	0.00587	0.00496	-0.01279	0.04239	-0.00704	0.00800	-0.03256
61.Male driver	0.05138	0.04052	0.06208	0.04269	0.32190	0.01324	-0.03046	0.02408	-0.02061	-0.04014	-0.03352	0.06747	-0.10791	-0.01848	0.17242	-0.03294	0.01288
62.Driver seatbelt not used	0.04260	0.00792	0.03089	-0.00362	0.04539	-0.02690	-0.01536	0.10168	-0.01001	-0.01234	-0.00703	0.01517	-0.04666	-0.01389	0.03642	-0.01339	0.02967
63.Seatbelt do not wear	0.00539	-0.01208	-0.01825	-0.02229	-0.12075	-0.04755	-0.02024	0.11482	-0.01644	-0.02658	-0.00103	0.02335	-0.04716	0.01660	0.03293	-0.01146	0.03623
64.Occupants Ejection	-0.00621	-0.01099	-0.00644	-0.00559	-0.02451	-0.01242	0.00454	0.06210	-0.00046	-0.01502	0.00236	0.00604	-0.06223	-0.00473	0.05895	-0.01421	0.02744
65.Occupants Front Seat	0.05620	0.04149	0.09329	0.04698	0.35985	0.05569	0.01054	-0.02239	-0.00086	0.00241	-0.01031	0.00785	-0.00254	-0.05365	0.04728	-0.01986	0.01053
66.Female occupants	0.00052	-0.00178	0.02437	0.00050	0.01211	0.02075	0.04041	-0.05968	0.02831	0.05066	0.03520	-0.07934	0.13140	0.00404	-0.19277	0.02698	0.00051

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.3 (continued)

Variable	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1.Teenage distracted by cell phone	-0.03773	-0.00242	-0.03245	-0.01860	-0.02920	-0.01491	0.03003	0.02204	-0.01117	0.00643	0.00792	-0.00981	0.01121	-0.00396	-0.00718	0.01125
2.Teenage distracted by other electronic devices	-0.03863	0.00415	-0.02579	-0.01141	-0.01982	-0.00850	0.02659	0.00574	-0.02835	0.02165	0.00653	-0.00569	0.00818	-0.00461	-0.01588	0.00345
3.Teenage distracted In/on-vehicle	-0.07125	0.00382	-0.02683	0.00917	-0.02959	-0.02078	0.02929	0.02306	-0.00160	0.00595	-0.00344	-0.00876	0.00693	0.00236	-0.03023	0.00407
4.External distraction teenage	-0.00279	0.00847	-0.01985	0.00417	-0.00193	0.01469	-0.00150	-0.01921	-0.02315	0.03815	-0.02793	0.02034	-0.00744	-0.02073	-0.01279	-0.01480
5.Inattentive teenage	0.05401	0.00277	0.05579	0.00214	0.07952	0.05288	-0.06490	-0.09177	0.05047	0.00537	-0.08643	0.00315	0.01848	-0.03838	0.03851	-0.04421
6.Valid licensed	-0.01899	-0.00542	-0.01343	-0.00421	0.03183	-0.00071	0.00192	-0.03978	-0.07613	0.05622	0.02723	0.00094	0.02294	-0.04426	0.01116	-0.01548
7.Restricted license	0.01075	-0.01422	-0.00391	-0.00405	-0.01429	0.00916	0.00438	0.00028	-0.02164	0.01883	0.00802	0.00171	-0.00806	0.01224	-0.01280	-0.00609
8.Alchohol/drug related	-0.03928	0.01066	-0.02097	-0.01718	-0.06097	-0.06858	0.03553	0.14537	0.00860	-0.01926	0.01732	-0.01932	-0.02457	0.07720	0.00170	0.03692
9.Vehicle age (Year 5 or newer)	0.02462	0.00185	0.01043	-0.01404	0.00912	0.00738	0.00610	-0.02671	0.00325	-0.01447	0.00965	-0.00312	0.01469	-0.02026	-0.00613	0.03041
10.Vehicle age (6-10 years)	-0.00893	0.00299	0.01395	-0.01885	0.00242	0.01213	0.00948	-0.03218	-0.00625	0.00360	0.00419	-0.00089	0.01628	-0.02749	-0.02848	0.00702
11.Vehicle age (11-15 years)	0.00092	-0.00585	0.00354	-0.01687	-0.02328	0.00504	0.01179	0.01746	-0.01560	-0.01254	0.04153	0.01578	-0.00607	-0.01517	0.01317	-0.01879
12.Vehicle age (Year 16 or older)	-0.00450	0.00257	-0.01575	0.02841	0.01658	-0.01432	-0.01977	0.01621	0.01715	0.01442	-0.04452	-0.01245	-0.01096	0.03969	0.01049	0.00224
13.Automobile	0.00402	-0.01364	-0.03903	-0.06080	-0.09533	0.04820	0.07710	-0.03742	-0.00702	0.01131	-0.00374	0.03626	0.02339	-0.10234	-0.00358	-0.00774
14.Van	0.00450	0.00570	0.00353	-0.00902	-0.01161	0.00959	0.00802	-0.00986	0.01346	-0.02187	0.01956	-0.01044	0.01088	-0.00595	-0.01351	0.00989
15.Pickup-truck, camper-rv	-0.01409	0.02054	0.03977	0.06621	0.07139	-0.04350	-0.06555	0.04197	-0.00344	-0.00208	0.01287	-0.02527	-0.04069	0.11549	0.00650	0.01134
16.Sport vehicle	0.00680	-0.00761	0.01124	0.01577	0.05918	-0.02240	-0.03964	0.01232	0.00564	-0.00172	-0.01615	-0.01768	0.00456	0.02261	0.00662	-0.00961
17.Straight-following maneuver	-0.70960	-0.24870	-0.46349	-0.04389	-0.12600	-0.05897	0.12261	0.09681	-0.10390	0.09493	0.02000	-0.01892	-0.00412	0.03890	-0.00854	0.04801
18.Turn/changing lanes maneuver	1.00000	-0.07153	-0.13330	-0.01049	0.03953	0.06685	-0.05355	-0.06982	0.04635	-0.03530	-0.01809	0.02852	0.00376	-0.05506	-0.00258	-0.03612
19.Avoiding maneuver	-0.07153	1.00000	-0.04672	-0.01890	-0.02918	0.00842	0.01912	0.00898	-0.03764	-0.00894	0.06803	-0.01842	-0.00169	0.03448	-0.00324	0.01569
20.Stopped/parking/backing maneuver	-0.13330	-0.04672	1.00000	0.09376	0.18352	0.00650	-0.14194	-0.08531	0.12495	-0.09751	-0.04949	0.00587	0.00260	-0.01398	0.01932	-0.03900
21.No damage	-0.01049	-0.01890	0.09376	1.00000	-0.07127	-0.08667	-0.09995	-0.04141	0.03886	-0.01860	-0.03025	0.00035	0.00255	-0.00445	-0.00750	-0.03156
22.Minor damage	0.03953	-0.02918	0.18352	-0.07127	1.00000	-0.35229	-0.40630	-0.16834	0.10408	-0.04487	-0.09833	0.02832	0.00811	-0.06329	-0.01181	-0.05517
23.Functional damage	0.06685	0.00842	0.00650	-0.08667	-0.35229	1.00000	-0.49406	-0.20471	0.05854	-0.00987	-0.06711	0.02753	0.01885	-0.07851	0.01015	-0.04806
24.Disabling damage	-0.05355	0.01912	-0.14194	-0.09995	-0.40630	-0.49406	1.00000	-0.23609	-0.08253	0.04489	0.05604	-0.02054	-0.01339	0.05865	0.00741	0.05162
25.Destroyed damage	-0.06982	0.00898	-0.08531	-0.04141	-0.16834	-0.20471	-0.23609	1.00000	-0.12936	0.01623	0.17506	-0.04836	-0.02336	0.12235	-0.01164	0.08466
26.Speed limit<35 mph	0.04635	-0.03764	0.12495	0.03886	0.10408	0.05854	-0.08253	-0.12936	1.00000	-0.77077	-0.25140	-0.04190	0.06555	-0.05007	-0.02498	-0.02033
27.Speed limit 35-60 mph	-0.03530	-0.00894	-0.09751	-0.01860	-0.04487	-0.00987	0.04489	0.01623	-0.77077	1.00000	-0.37905	-0.01591	-0.04209	0.10296	0.02281	-0.03481
28.Speed limit>60 mph	-0.01809	0.06803	-0.04949	-0.03025	-0.09833	-0.06711	0.05604	0.17506	-0.25140	-0.37905	1.00000	0.08964	-0.03057	-0.09278	-0.00231	0.07727
29.Concrete roads	0.02852	-0.01842	0.00587	0.00035	0.02832	0.02753	-0.02054	-0.04836	-0.04190	-0.01591	0.08964	1.00000	-0.83305	-0.15562	0.00042	0.00217
30.Black top roads	0.00376	-0.00169	0.00260	0.00255	0.00811	0.01885	-0.01339	-0.02336	0.06555	-0.04209	-0.03057	-0.83305	1.00000	-0.41092	-0.00261	-0.04473
31.Gravel/brick roads	-0.05506	0.03448	-0.01398	-0.00445	-0.06329	-0.07851	0.05865	0.12235	-0.05007	0.10296	-0.09278	-0.15562	-0.41092	1.00000	0.00407	0.07678
32.Wet/debris roads	-0.00258	-0.00324	0.01932	-0.00750	-0.01181	0.01015	0.00741	-0.01164	-0.02498	0.02281	-0.00231	0.00042	-0.00261	0.00407	1.00000	0.00978
33.Curved road	-0.03612	0.01569	-0.03900	-0.03156	-0.05517	-0.04806	0.05162	0.08466	-0.02033	-0.03481	0.07727	0.00217	-0.04473	0.07678	0.00978	1.00000
34.Work zone related	-0.00633	-0.00221	0.00275	0.01246	0.00086	0.01495	-0.00718	-0.01995	-0.05227	0.01964	0.04930	0.04881	-0.02497	-0.03918	-0.02587	0.00077
35.Multi lanes road	0.01493	-0.00351	-0.06799	-0.01499	-0.01754	0.00204	0.01876	0.00194	-0.07198	0.08097	0.00914	-0.00918	0.07571	-0.10675	-0.00431	-0.04993
36.5.00-9.00-morning	-0.02598	0.00304	-0.01759	-0.02199	-0.04142	-0.00503	0.03013	0.02791	-0.01986	-0.01430	0.06024	0.00970	0.01432	-0.04027	0.05214	0.00750
37.9.00-13.00-noon	0.01575	-0.00344	0.01156	0.01114	0.00980	0.02555	-0.03233	-0.00665	0.01115	-0.01065	0.00477	0.00382	0.01505	-0.03285	0.00771	-0.00924
38.13.00-17.00-afternoon	-0.00881	0.00240	0.01887	0.01284	0.04293	0.05295	-0.04935	-0.07211	0.01890	0.01909	-0.06653	0.00769	0.01666	-0.04206	-0.03600	-0.05085
39.17.00-21.00-evening	0.02868	-0.00919	0.00980	0.01353	0.04108	-0.00828	-0.01008	-0.03346	-0.03012	0.03175	-0.00301	-0.00098	-0.00110	0.00153	-0.01823	-0.00874
40.21.00-5.00-night	-0.01414	0.00884	-0.03413	-0.02499	-0.08097	-0.08189	0.08411	0.11925	0.01811	-0.03960	0.03112	-0.02238	-0.04968	0.12606	0.01332	0.08113
41.Weekend	-0.00377	0.00244	-0.02986	-0.01301	-0.04479	-0.06114	0.04626	0.09120	-0.01595	-0.02652	0.06442	-0.01404	-0.01887	0.05816	0.00775	0.06134
42.Head On crash	0.11286	-0.00881	-0.03352	-0.00549	-0.02852	-0.01263	0.01001	0.04947	0.02316	-0.02687	-0.00033	-0.00591	0.00313	0.00491	0.00636	-0.00717
43.Rear end crash	-0.31658	-0.06000	0.04823	0.02774	0.10713	0.10122	-0.08255	-0.19144	-0.16473	0.22055	-0.09234	0.07611	0.04883	-0.21293	0.01148	-0.15699
44.Angle crash	0.33887	-0.02905	-0.08533	-0.04593	-0.02086	0.05333	0.01023	-0.05018	0.12987	-0.07381	-0.08040	-0.02074	0.04726	-0.05438	0.00548	-0.07237
45.Opposite direction crash	0.05299	0.02830	-0.02609	0.00666	0.01472	0.00674	-0.01259	-0.01187	0.00189	-0.01319	0.01185	-0.00769	-0.00708	0.02611	-0.00694	0.02203
46.Same direction crash	0.32117	0.05774	-0.05555	-0.00828	0.08919	0.07032	-0.10797	-0.05547	-0.03199	-0.01376	0.06968	0.05219	-0.02373	-0.04335	-0.02528	-0.00012
47.Backed into crash	-0.04936	-0.01559	0.35918	0.02762	0.11622	-0.00652	-0.08269	-0.03424	0.11668	-0.10097	-0.02931	0.00379	-0.01601	0.02318	-0.01978	-0.01531
48.Single-vehicle crash	-0.07871	0.05481	-0.11085	-0.05267	-0.17868	-0.15633	0.18985	0.21663	-0.08940	-0.01018	0.15025	-0.05125	-0.07478	0.21948	0.01967	0.22541
49.On roadway crash	-0.02734	0.00557	0.06129	0.01880	0.03765	0.02823	-0.03268	-0.05173	0.10888	-0.06884	-0.05087	-0.01113	0.00557	0.01050	-0.00504	-0.02839
50.At intersection crash	0.08940	-0.05919	-0.00717	0.01066	0.07389	0.07983	-0.05867	-0.14321	-0.01849	0.09166	-0.10193	0.06843	0.02635	-0.16289	-0.00057	-0.11667
51.Off roadway crash	-0.08671	0.07331	-0.07062	-0.04031	-0.14750	-0.14290	0.12011	0.25946	-0.12129	-0.03199	0.20815	-0.07634	-0.03978	0.19853	0.00764	0.19694
52.Dark	0.00268	0.00605	-0.04098	-0.01910	-0.06101	-0.08089	0.07692	0.09879	-0.01392	-0.00908	0.03077	-0.01977	-0.04395	0.11004	0.06375	0.07404
53.Adverse conditions	0.00113	-0.00463	0.01126	-0.00446	-0.01543	0.00223	0.01404	-0.00841	-0.03394	0.02475	0.00789	-0.00111	0.01141	-0.01921	0.77542	0.00777
54.Rural roads	-0.06192	0.06623	-0.00509	-0.02154	-0.10553	-0.11450	0.06667	0.23572	-0.17303	0.06479	0.15936	-0.17863	-0.05280	0.39200	-0.00701	0.07821
55.Animall factors	-0.00442	0.02740	-0.00880	-0.00638	-0.02159	0.00033	0.01776	0.00272	-0.01590	-0.00078	0.02468	-0.02798	0.01561	0.01708	0.21047	0.01405
56.Weatherl factors	0.00391	0.02973	0.00195	-0.00943	-0.01027	-0.01572	0.02297	0.00796	-0.01754	-0.00290	0.02856	-0.00940	0.00317	0.01042	0.11925	0.00089
57.Vision obstruction	-0.00523	0.00650	-0.00476	-0.00547	-0.01016	0.01254	-0.00185	0.00123	-0.00611	0.00396	-0.00165	-0.00904	0.00829	0.00030	0.02458	0.01414
58.Vehicle factors	0.00060	-0.01090	-0.00681	-0.00804	-0.00998	0.00540	0.01133	-0.00928	0.01311	-0.00663	-0.00677	-0.00734	0.01139	-0.00785	0.01779	-0.00109
59.Road factors	-0.01573	0.00755	0.00484	-0.00806	-0.01841	-0.02220	0.03185	0.00645	-0.04937	0.00839	0.05632	-0.00637	-0.00244	0.01427	0.31595	0.01597
60.Passenger	0.03976	-0.00366	0.00303	0.01060	-0.02032	-0.01073	0.01118	0.02290	0.00217	-0.01169	0.01314	0.00256	-0.03264	0.05512	-0.00586	0.02471
61.Male driver	-0.02159	0.02341	-0.00834	0.00914	0.01380	-0.00613	-0.02222	0.01981	-0.00513	0.00147	0.00889	-0.00627	0.00862	-0.00407	0.00659	0.00931
62.Driver seatbelt not used	-0.02480	0.01634	-0.02787	-0.00262	-0.05969	-0.06245	0.04087	0.12192	-0.03262	0.01549	0.02328	-0.02494	-0.01503	0.06938	-0.00652	0.02961
63.Seatbelt do not wear	-0.03182	0.01607	-0.03013	0.00378	-0.07802	-0.06080	0.03968	0.14642	-0.03684	0.00374	0.04905	-0.02134	-0.03129	0.09250	-0.01672	0.04858
64.Occupants Ejection	-0.02311	0.01389	-0.02589	0.01037	-0.03809	-0.04910	-0.00772	0.14496	-0.03955	-0.01425	0.07277	0.00097	-0.02623	0.04611	-0.00506	0.02753
65.Occupants Front Seat	-0.01982	0.00651	0.00600	-0.01173	0.02461	0.00488	-0.01063	-0.01994	0.00071	0.01751	-0.02668	-0.00716	0.02727	-0.03852	0.00758	-0.01957
66.Female occupants	0.01013	-0.02791	0.00184	-0.01118	-0.00980	0.01353	0.02123	-0.03541	0.00090	0.00658	-0.01162	0.00801	0.00932	-0.03179	-0.01027	-0.03231

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.3 (continued)

Variable	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
1.Teenage distracted by cell phone	-0.00873	-0.00583	-0.01062	-0.01247	-0.02121	0.00070	0.05111	0.01353	-0.00919	-0.02763	-0.01839	-0.00650	-0.01450	-0.01479	0.05209	-0.00823
2.Teenage distracted by other electronic devices	0.00282	0.00468	-0.00960	0.00044	-0.00369	0.00230	0.01051	0.01409	-0.01414	0.01236	-0.02570	0.00859	-0.01472	-0.01423	0.02661	-0.00178
3.Teenage distracted In/on-vehicle	-0.00801	0.01080	0.00664	0.00329	0.00496	0.00331	-0.02025	0.00258	0.00857	0.00931	-0.06080	-0.00203	-0.03297	-0.02066	0.04601	-0.00911
4.External distraction teenage	-0.00816	0.00696	-0.01044	-0.00060	0.00912	0.00931	-0.01256	-0.00639	-0.00069	0.06289	-0.02760	0.00710	-0.01734	-0.00813	-0.03791	0.00453
5.Inattentive teenage	0.00739	-0.01778	0.02292	0.04138	0.04128	-0.01882	-0.09747	-0.08949	0.00324	0.09618	0.05543	-0.01481	0.01206	0.02882	-0.16119	0.03640
6.Valid licensed	0.00818	0.01401	0.00674	0.00330	0.01987	0.01917	-0.05913	-0.03310	0.00668	0.10258	-0.01060	-0.01508	0.00346	-0.00212	-0.07209	-0.00088
7.Restricted license	-0.00067	-0.00066	0.03103	-0.00761	-0.00509	0.00639	-0.02188	-0.02128	-0.00072	-0.00060	0.00465	0.00173	0.00187	0.00465	-0.00911	-0.00870
8.Alchohol/drug related	-0.00288	-0.03232	-0.01691	-0.05114	-0.08777	-0.04594	0.24466	0.09690	0.00288	-0.10307	-0.04128	-0.00487	-0.03673	-0.01824	0.13796	-0.00878
9.Vehicle age (Year 5 or newer)	-0.00290	0.00928	0.00055	-0.00894	-0.01433	0.00751	0.01973	0.00929	-0.00198	-0.01247	0.00672	-0.00063	0.01995	0.01583	0.00924	-0.01799
10.Vehicle age (6-10 years)	0.00499	0.00911	-0.01219	0.00762	-0.00761	0.01792	-0.00742	-0.00265	-0.00493	0.00590	0.01630	-0.01241	0.02190	0.01454	-0.01645	-0.01199
11.Vehicle age (11-15 years)	0.00365	-0.00681	0.00017	-0.00036	0.00314	-0.00253	-0.00092	0.00165	-0.00999	0.01786	-0.02003	-0.00029	-0.00083	-0.00334	0.00560	-0.01170
12.Vehicle age (Year 16 or older)	-0.00546	-0.00217	0.00830	-0.00091	0.00753	-0.01264	-0.00214	-0.00274	0.01430	-0.01705	0.00467	0.00741	-0.02227	-0.01204	0.00428	0.02539
13.Automobile	0.02119	0.01124	-0.00826	-0.01118	0.00416	0.00724	0.00758	-0.01799	-0.00007	0.04084	0.02255	-0.00681	0.00022	-0.03068	-0.00776	-0.00719
14.Van	0.00531	-0.01223	0.00383	0.01785	0.00362	-0.00352	-0.02206	-0.00570	0.00348	-0.02154	0.00034	0.00759	0.02502	-0.00756	0.00036	-0.00103
15.Pickup-truck, camper-rv	-0.02168	-0.00738	0.01142	0.00214	-0.01115	-0.01026	0.01116	0.03225	-0.00267	-0.04993	-0.01594	0.01737	-0.00705	0.03357	0.01958	0.01134
16.Sport vehicle	-0.00725	-0.00058	-0.00103	0.00353	0.00317	0.00240	-0.01026	-0.00778	0.00177	0.01091	-0.01296	-0.01222	-0.00459	0.01109	-0.01100	-0.00369
17.Straight-following maneuver	0.00550	0.03120	0.02970	-0.01894	0.00117	-0.02232	0.01741	0.01840	-0.07244	0.27113	-0.21862	-0.04222	-0.25441	-0.16623	0.09724	-0.01890
18.Turn/changing lanes maneuver	-0.00633	0.01493	-0.02598	0.01575	-0.00881	0.02868	-0.01414	-0.00377	0.11286	-0.31658	0.33887	0.05299	0.32117	-0.04936	-0.07871	-0.02734
19.Avoiding maneuver	-0.00221	-0.00351	0.00304	-0.00344	0.00240	-0.00919	0.00884	0.00244	-0.00881	-0.06000	-0.02905	0.02830	0.05774	-0.01559	0.05481	0.00557
20.Stopped/parking/backing maneuver	0.00275	-0.06799	-0.01759	0.01156	0.01887	0.00980	-0.03413	-0.02986	-0.03352	0.04823	-0.08533	-0.02609	-0.05555	0.35918	-0.11085	0.06129
21.No damage	0.01246	-0.01499	-0.02199	0.01114	0.01284	0.01353	-0.02499	-0.01301	-0.00549	0.02774	-0.04593	0.00666	-0.00828	0.02762	-0.05267	0.01880
22.Minor damage	0.00086	-0.01754	-0.04142	0.00980	0.04293	0.04108	-0.08097	-0.04479	-0.02852	0.10713	-0.02086	0.01472	0.08919	0.11622	-0.17868	0.03765
23.Functional damage	0.01495	0.00204	-0.00503	0.02555	0.05295	-0.00828	-0.08189	-0.06114	-0.01263	0.10122	0.05333	0.00674	0.07032	-0.00652	-0.15633	0.02823
24.Disabling damage	-0.00718	0.01876	0.03013	-0.03233	-0.04935	-0.01008	0.08411	0.04626	0.01001	-0.08255	0.01023	-0.01259	-0.10797	-0.08269	0.18985	-0.03268
25.Destroyed damage	-0.01995	0.00194	0.02791	-0.00665	-0.07211	-0.03346	0.11925	0.09120	0.04947	-0.19144	-0.05018	-0.01187	-0.05547	-0.03424	0.21663	-0.05173
26.Speed limit<35 mph	-0.05227	-0.07198	-0.01986	0.01115	0.01890	-0.03012	0.01811	-0.01595	0.02316	-0.16473	0.12987	0.00189	-0.03199	0.11668	-0.08940	0.10888
27.Speed limit 35-60 mph	0.01964	0.08097	-0.01430	-0.01065	0.01909	0.03175	-0.03960	-0.02652	-0.02687	0.22055	-0.07381	-0.01319	-0.01376	-0.10097	-0.01018	-0.06884
28.Speed limit>60 mph	0.04930	0.00914	0.06024	0.00477	-0.06653	-0.00301	0.03112	0.06442	-0.00033	-0.09234	-0.08040	0.01185	0.06968	-0.02931	0.15025	-0.05087
29.Concrete roads	0.04881	-0.00918	0.00970	0.00382	0.00769	-0.00098	-0.02238	-0.01404	-0.00591	0.07611	-0.02074	-0.00769	0.05219	0.00379	-0.05125	-0.01113
30.Black top roads	-0.02497	0.07571	0.01432	0.01505	0.01666	-0.00110	-0.04968	-0.01887	0.00313	0.04883	0.04726	-0.00708	-0.02373	-0.01601	-0.07478	0.00557
31.Gravel/brick roads	-0.03918	-0.10675	-0.04027	-0.03285	-0.04206	0.00153	0.12606	0.05816	0.00491	-0.21293	-0.05438	0.02611	-0.04335	0.02318	0.21948	0.01050
32.Wet/debris roads	-0.02587	-0.00431	0.05214	0.00771	-0.03600	-0.01823	0.01332	0.00775	0.00636	0.01148	0.00548	-0.00694	-0.02528	-0.01978	0.01967	-0.00504
33.Curved road	0.00077	-0.04993	0.00750	-0.00924	-0.05085	-0.00874	0.08113	0.06134	-0.00717	-0.15699	-0.07237	0.02203	-0.00012	-0.01531	0.22541	-0.02839
34.Work zone related	1.00000	-0.01404	-0.01482	0.02259	0.01122	-0.00479	-0.01787	-0.02073	-0.00984	0.08655	-0.04163	-0.00538	0.01904	-0.00926	-0.03589	0.02072
35.Multi lanes road	-0.01404	1.00000	0.00366	0.00826	0.01458	0.00257	-0.03533	0.00336	0.01418	0.06020	0.00609	-0.01424	0.03339	-0.04292	-0.03467	-0.01253
36.5.00-9.00-morning	-0.01482	0.00366	1.00000	-0.16534	-0.26591	-0.21943	-0.15453	-0.08870	0.00307	-0.01011	-0.01443	-0.00277	-0.02861	-0.01687	0.03434	0.01749
37.9.00-13.00-noon	0.02259	0.00826	-0.16534	1.00000	-0.30026	-0.24778	-0.17449	0.04962	-0.00281	0.01488	0.03425	-0.01452	0.02440	0.01088	-0.03055	-0.01276
38.13.00-17.00-afternoon	0.01122	0.01458	-0.26591	-0.30026	1.00000	-0.39850	-0.28063	-0.07580	0.00669	0.13989	0.00673	0.01063	0.01095	0.02371	-0.13656	0.00053
39.17.00-21.00-evening	-0.00479	0.00257	-0.21943	-0.24778	-0.39850	1.00000	-0.23158	-0.03829	0.00500	0.03027	0.02245	0.00582	0.01130	0.00088	-0.06511	-0.00302
40.21.00-5.00-night	-0.01787	-0.03533	-0.15453	-0.17449	-0.28063	-0.23158	1.00000	0.18105	-0.01463	-0.23056	-0.05887	-0.00319	-0.02584	-0.02777	0.26067	-0.00084
41.Weekend	-0.02073	0.00336	-0.08870	0.04962	-0.07580	-0.03829	0.18105	1.00000	-0.01179	-0.15685	-0.01594	0.01108	0.01729	-0.00784	0.15169	-0.01266
42.Head On crash	-0.00984	0.01418	0.00307	-0.00281	0.00669	0.00500	-0.01463	-0.01179	1.00000	-0.11893	-0.05926	-0.01439	-0.03052	-0.01516	-0.06379	0.00935
43.Rear end crash	0.08655	0.06020	-0.01011	0.01488	0.13989	0.03027	-0.23056	-0.15685	-0.11893	1.00000	-0.39613	-0.09618	-0.20400	-0.10132	-0.42642	0.02236
44.Angle crash	-0.04163	0.00609	-0.01443	0.03425	0.00673	0.02245	-0.05887	-0.01594	-0.05926	-0.39613	1.00000	-0.04792	-0.10165	-0.05048	-0.21247	-0.14806
45.Opposite direction crash	-0.00538	-0.01424	-0.00277	-0.01452	0.01063	0.00582	-0.00319	0.01108	-0.01439	-0.09618	-0.04792	1.00000	-0.02468	-0.01226	-0.05159	0.05380
46.Same direction crash	0.01904	0.03339	-0.02861	0.02440	0.01095	0.01130	-0.02584	0.01729	-0.03052	-0.20400	-0.10165	-0.02468	1.00000	-0.02600	-0.10942	0.09889
47.Backed into crash	-0.00926	-0.04292	-0.01687	0.01088	0.02371	0.00088	-0.02777	-0.00784	-0.01516	-0.10132	-0.05048	-0.01226	-0.02600	1.00000	-0.05434	0.06962
48.Single-vehicle crash	-0.03589	-0.03467	0.03434	-0.03055	-0.13656	-0.06511	0.26067	0.15169	-0.06379	-0.42642	-0.21247	-0.05159	-0.10942	-0.05434	1.00000	-0.14013
49.On roadway crash	0.02072	-0.01253	0.01749	-0.01276	0.00053	-0.00302	-0.00084	-0.01266	0.00935	0.02236	-0.14806	0.05380	0.09889	0.06962	-0.14013	1.00000
50.At intersection crash	0.00937	0.04876	-0.03562	0.03150	0.06462	0.04747	-0.14295	-0.08468	0.02480	0.25804	0.27022	-0.02615	-0.02458	-0.05720	-0.34107	-0.71987
51.Off roadway crash	-0.04273	-0.04484	0.02671	-0.02404	-0.08605	-0.06146	0.19016	0.12809	-0.04518	-0.37461	-0.16682	-0.03534	-0.09663	-0.01418	0.63971	-0.34763
52.Dark	-0.02844	-0.02650	-0.14681	-0.24978	-0.38743	0.20652	0.66737	0.15581	-0.00778	-0.19753	-0.04358	-0.00850	-0.01416	-0.04592	0.21570	-0.00423
53.Adverse conditions	-0.01571	0.00439	0.03412	0.00189	-0.03216	-0.00105	0.01017	0.01308	0.01254	0.00855	0.00085	-0.00322	-0.01309	-0.01300	0.01486	-0.00494
54.Rural roads	-0.04640	-0.03128	0.02803	-0.03422	-0.05741	-0.01500	0.10325	0.06948	0.00338	-0.29262	-0.03516	0.02778	-0.05895	0.04772	0.30070	-0.01867
55.Animall factors	0.00474	0.00057	0.05599	-0.00447	-0.03137	-0.00861	0.00464	0.00306	-0.00047	-0.01906	0.01350	0.00069	-0.00509	-0.00831	0.00839	0.01640
56.Weatherl factors	-0.00756	-0.00666	0.04640	-0.00826	-0.02067	-0.00598	-0.00016	0.00474	0.00040	-0.00991	0.01101	-0.00633	-0.00608	-0.00709	0.00187	0.00510
57.Vision obstruction	0.00591	0.00805	0.03248	0.00152	-0.01580	0.00199	-0.01378	0.00461	0.00218	-0.00843	0.00066	-0.00445	-0.00482	-0.00469	0.01130	0.00840
58.Vehicle factors	0.02136	-0.00555	0.03729	-0.00034	-0.01475	0.00436	-0.02060	-0.00166	0.00995	-0.00800	-0.01363	-0.00062	-0.01364	-0.01002	0.01630	-0.00028
59.Road factors	0.08040	-0.01063	0.01975	0.02169	-0.03270	-0.00865	0.01339	0.01873	-0.00665	0.00457	-0.01896	-0.01221	-0.01172	-0.01373	0.03270	0.01027
60.Passenger	0.00025	0.00712	-0.05988	-0.02704	-0.00653	0.04489	0.03893	0.04382	0.00229	-0.06161	0.03040	0.00854	0.03145	0.00198	0.02716	-0.01439
61.Male driver	-0.00103	-0.00323	0.03506	-0.00312	-0.01937	-0.02919	0.03105	-0.00405	0.00431	0.00147	-0.03895	0.00840	-0.01250	-0.01074	0.02919	0.01307
62.Driver seatbelt not used	-0.01457	-0.01347	-0.00003	-0.00596	-0.03657	-0.00757	0.06509	0.03675	0.00291	-0.07201	-0.02366	-0.00613	-0.01843	-0.01677	0.07821	0.00432
63.Seatbelt do not wear	-0.00544	-0.01812	-0.00709	-0.00566	-0.04372	-0.00022	0.07221	0.05405	0.00327	-0.09213	-0.03274	-0.00294	-0.02214	-0.01027	0.10504	-0.00064
64.Occupants Ejection	-0.01433	-0.02609	0.01786	-0.01565	-0.01213	-0.01496	0.03186	0.04214	-0.00806	-0.07152	-0.02227	-0.00499	-0.01349	-0.00997	0.06218	-0.02006
65.Occupants Front Seat	-0.00622	-0.00230	0.04297	0.01092	0.01080	-0.01927	-0.04373	-0.03544	0.00491	0.03853	-0.01182	0.00311	-0.01380	-0.00081	-0.02673	0.02208
66.Female occupants	0.00637	0.00288	-0.01228	0.02100	0.03063	0.01277	-0.06599	-0.02703	0.00493	0.03327	0.03217	-0.01078	0.00700	0.00695	-0.05615	-0.00420

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.3 (continued)

Variable	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
1.Teenage distracted by cell phone	-0.02009	0.03940	0.04768	-0.00328	0.00999	-0.02187	-0.00846	0.00521	-0.00634	-0.01748	-0.10635	0.05138	0.04260	0.00539	-0.00621	0.05620	0.00052
2.Teenage distracted by other electronic devices	-0.01223	0.01891	0.00378	-0.01644	-0.00196	-0.01101	-0.00151	-0.00517	-0.01105	-0.00209	-0.07851	0.04052	0.00792	-0.01208	-0.01099	0.04149	-0.00178
3.Teenage distracted In/on-vehicle	-0.02460	0.04485	-0.01679	-0.02548	0.02203	-0.01240	-0.01385	-0.00005	0.00969	-0.01167	-0.17653	0.06208	0.03089	-0.01825	-0.00644	0.09329	0.02437
4.External distraction teenage	0.02502	-0.03984	-0.01685	-0.01504	-0.04145	0.01060	0.00819	0.00139	-0.01251	-0.00450	-0.08891	0.04269	-0.00362	-0.02229	-0.00559	0.04698	0.00050
5.Inattentive teenage	0.07215	-0.14411	-0.09210	0.02924	-0.08639	0.01099	0.01205	-0.00040	0.00315	0.00510	-0.58096	0.32190	0.04539	-0.12075	-0.02451	0.35985	0.01211
6.Valid licensed	0.03261	-0.03639	-0.04240	0.00964	0.00653	0.01415	0.00003	-0.00507	0.00019	0.01526	-0.07187	0.01324	-0.02690	-0.04755	-0.01242	0.05569	0.02075
7.Restricted license	0.00825	0.00200	-0.00907	-0.00811	0.02234	0.00631	-0.00338	0.01112	-0.01029	-0.00687	-0.00939	-0.03046	-0.01536	-0.02024	0.00454	0.01054	0.04041
8.Alchohol/drug related	-0.07612	0.10890	0.18472	-0.00041	0.07533	-0.00120	-0.00715	-0.00663	-0.01113	0.00808	0.02792	0.02408	0.10168	0.11482	0.06210	-0.02239	-0.05968
9.Vehicle age (Year 5 or newer)	0.00887	0.01318	0.02281	-0.00883	-0.00890	-0.00693	-0.00591	-0.00769	0.00200	0.00431	-0.00815	-0.02061	-0.01001	-0.01644	-0.00046	-0.00086	0.02831
10.Vehicle age (6-10 years)	0.01187	-0.00030	0.01063	-0.02583	-0.02248	0.00576	-0.01539	-0.01385	-0.02078	-0.01428	-0.00999	-0.04014	-0.01234	-0.02658	-0.01502	0.00241	0.05066
11.Vehicle age (11-15 years)	0.00627	0.00685	0.00939	0.01139	-0.00701	0.01152	0.00258	-0.00326	-0.01345	0.01788	0.00587	-0.03352	-0.00703	-0.00103	0.00236	-0.01031	0.03520
12.Vehicle age (Year 16 or older)	-0.01843	-0.00897	-0.02491	0.01109	0.02731	-0.01254	0.01009	0.01571	0.02690	-0.00869	0.00496	0.06747	0.01517	0.02335	0.00604	0.00785	-0.07934
13.Automobile	0.04149	-0.04504	0.01683	0.00805	-0.10326	0.00129	0.00004	-0.00085	0.01805	-0.00235	-0.01279	-0.10791	-0.04666	-0.04716	-0.06223	-0.00254	0.13140
14.Van	-0.00595	0.00807	-0.01829	-0.01131	0.01047	0.00125	-0.00977	-0.00160	-0.01034	0.00069	0.04239	-0.01848	-0.01389	0.01660	-0.00473	-0.05365	0.00404
15.Pickup-truck, camper-rv	-0.04951	0.05336	0.00119	-0.00557	0.14110	0.01526	0.00651	0.00345	-0.01477	0.00321	-0.00704	0.17242	0.03642	0.03293	0.05895	0.04728	-0.19277
16.Sport vehicle	0.00095	0.00099	-0.01353	0.00204	-0.01201	-0.01682	-0.00214	-0.00118	-0.00280	-0.00146	0.00800	-0.03294	-0.01339	-0.01146	-0.01421	-0.01986	0.02698
17.Straight-following maneuver	-0.03715	0.07743	0.00946	-0.00460	0.02708	-0.00195	-0.01244	0.00628	0.00905	0.00468	-0.03256	0.01288	0.02967	0.03623	0.02744	0.01053	0.00051
18.Turn/changing lanes maneuver	0.08940	-0.08671	0.00268	0.00113	-0.06192	-0.00442	0.00391	-0.00523	0.00060	-0.01573	0.03976	-0.02159	-0.02480	-0.03182	-0.02311	-0.01982	0.01013
19.Avoiding maneuver	-0.05919	0.07331	0.00605	-0.00463	0.06623	0.02740	0.02973	0.00650	-0.01090	0.00755	-0.00366	0.02341	0.01634	0.01607	0.01389	0.00651	-0.02791
20.Stopped/parking/backing maneuver	-0.00717	-0.07062	-0.04098	0.01126	-0.00509	-0.00880	0.00195	-0.00476	-0.00681	0.00484	0.00303	-0.00834	-0.02787	-0.03013	-0.02589	0.00600	0.00184
21.No damage	0.01066	-0.04031	-0.01910	-0.00446	-0.02154	-0.00638	-0.00943	-0.00547	-0.00804	-0.00806	0.01060	0.00914	-0.00262	0.00378	0.01037	-0.01173	-0.01118
22.Minor damage	0.07389	-0.14750	-0.06101	-0.01543	-0.10553	-0.02159	-0.01027	-0.01016	-0.00998	-0.01841	-0.02032	0.01380	-0.05969	-0.07802	-0.03809	0.02461	-0.00980
23.Functional damage	0.07983	-0.14290	-0.08089	0.00223	-0.11450	0.00033	-0.01572	0.01254	0.00540	-0.02220	-0.01073	-0.00613	-0.06245	-0.06080	-0.04910	0.00488	0.01353
24.Disabling damage	-0.05867	0.12011	0.07692	0.01404	0.06667	0.01776	0.02297	-0.00185	0.01133	0.03185	0.01118	-0.02222	0.04087	0.03968	-0.00772	-0.01063	0.02123
25.Destroyed damage	-0.14321	0.25946	0.09879	-0.00841	0.23572	0.00272	0.00796	0.00123	-0.00928	0.00645	0.02290	0.01981	0.12192	0.14642	0.14496	-0.01994	-0.03541
26.Speed limit<35 mph	-0.01849	-0.12129	-0.01392	-0.03394	-0.17303	-0.01590	-0.01754	-0.00611	0.01311	-0.04937	0.00217	-0.00513	-0.03262	-0.03684	-0.03955	0.00071	0.00090
27.Speed limit 35-60 mph	0.09166	-0.03199	-0.00908	0.02475	0.06479	-0.00078	-0.00290	0.00396	-0.00663	0.00839	-0.01169	0.00147	0.01549	0.00374	-0.01425	0.01751	0.00658
28.Speed limit>60 mph	-0.10193	0.20815	0.03077	0.00789	0.15936	0.02468	0.02856	-0.00165	-0.00677	0.05632	0.01314	0.00889	0.02328	0.04905	0.07277	-0.02668	-0.01162
29.Concrete roads	0.06843	-0.07634	-0.01977	-0.00111	-0.17863	-0.02798	-0.00940	-0.00904	-0.00734	-0.00637	0.00256	-0.00627	-0.02494	-0.02134	0.00097	-0.00716	0.00801
30.Black top roads	0.02635	-0.03978	-0.04395	0.01141	-0.05280	0.01561	0.00317	0.00829	0.01139	-0.00244	-0.03264	0.00862	-0.01503	-0.03129	-0.02623	0.02727	0.00932
31.Gravel/brick roads	-0.16289	0.19853	0.11004	-0.01921	0.39200	0.01708	0.01042	0.00030	-0.00785	0.01427	0.05512	-0.00407	0.06938	0.09250	0.04611	-0.03852	-0.03179
32.Wet/debris roads	-0.00057	0.00764	0.06375	0.77542	-0.00701	0.21047	0.11925	0.02458	0.01779	0.31595	-0.00586	0.00659	-0.00652	-0.01672	-0.00506	0.00758	-0.01027
33.Curved road	-0.11667	0.19694	0.07404	0.00777	0.07821	0.01405	0.00089	0.01414	-0.00109	0.01597	0.02471	0.00931	0.02961	0.04858	0.02753	-0.01957	-0.03231
34.Work zone related	0.00937	-0.04273	-0.02844	-0.01571	-0.04640	0.00474	-0.00756	0.00591	0.02136	0.08040	0.00025	-0.00103	-0.01457	-0.00544	-0.01433	-0.00622	0.00637
35.Multi lanes road	0.04876	-0.04484	-0.02650	0.00439	-0.03128	0.00057	-0.00666	0.00805	-0.00555	-0.01063	0.00712	-0.00323	-0.01347	-0.01812	-0.02609	-0.00230	0.00288
36.5.00-9.00-morning	-0.03562	0.02671	-0.14681	0.03412	0.02803	0.05599	0.04640	0.03248	0.03729	0.01975	-0.05988	0.03506	-0.00003	-0.00709	0.01786	0.04297	-0.01228
37.9.00-13.00-noon	0.03150	-0.02404	-0.24978	0.00189	-0.03422	-0.00447	-0.00826	0.00152	-0.00034	0.02169	-0.02704	-0.00312	-0.00596	-0.00566	-0.01565	0.01092	0.02100
38.13.00-17.00-afternoon	0.06462	-0.08605	-0.38743	-0.03216	-0.05741	-0.03137	-0.02067	-0.01580	-0.01475	-0.03270	-0.00653	-0.01937	-0.03657	-0.04372	-0.01213	0.01080	0.03063
39.17.00-21.00-evening	0.04747	-0.06146	0.20652	-0.00105	-0.01500	-0.00861	-0.00598	0.00199	0.00436	-0.00865	0.04489	-0.02919	-0.00757	-0.00022	-0.01496	-0.01927	0.01277
40.21.00-5.00-night	-0.14295	0.19016	0.66737	0.01017	0.10325	0.00464	-0.00016	-0.01378	-0.02060	0.01339	0.03893	0.03105	0.06509	0.07221	0.03186	-0.04373	-0.06599
41.Weekend	-0.08468	0.12809	0.15581	0.01308	0.06948	0.00306	0.00474	0.00461	-0.00166	0.01873	0.04382	-0.00405	0.03675	0.05405	0.04214	-0.03544	-0.02703
42.Head On crash	0.02480	-0.04518	-0.00778	0.01254	0.00338	-0.00047	0.00040	0.00218	0.00995	-0.00665	0.00229	0.00431	0.00291	0.00327	-0.00806	0.00491	0.00493
43.Rear end crash	0.25804	-0.37461	-0.19753	0.00855	-0.29262	-0.01906	-0.00991	-0.00843	-0.00800	0.00457	-0.06161	0.00147	-0.07201	-0.09213	-0.07152	0.03853	0.03327
44.Angle crash	0.27022	-0.16682	-0.04358	0.00085	-0.03516	0.01350	0.01101	0.00066	-0.01363	-0.01896	0.03040	-0.03895	-0.02366	-0.03274	-0.02227	-0.01182	0.03217
45.Opposite direction crash	-0.02615	-0.03534	-0.00850	-0.00322	0.02778	0.00069	-0.00633	-0.00445	-0.00062	-0.01221	0.00854	0.00840	-0.00613	-0.00294	-0.00499	0.00311	-0.01078
46.Same direction crash	-0.02458	-0.09663	-0.01416	-0.01309	-0.05895	-0.00509	-0.00608	-0.00482	-0.01364	-0.01172	0.03145	-0.01250	-0.01843	-0.02214	-0.01349	-0.01380	0.00700
47.Backed into crash	-0.05720	-0.01418	-0.04592	-0.01300	0.04772	-0.00831	-0.00709	-0.00469	-0.01002	-0.01373	0.00198	-0.01074	-0.01677	-0.01027	-0.00997	-0.00081	0.00695
48.Single-vehicle crash	-0.34107	0.63971	0.21570	0.01486	0.30070	0.00839	0.00187	0.01130	0.01630	0.03270	0.02716	0.02919	0.07821	0.10504	0.06218	-0.02673	-0.05615
49.On roadway crash	-0.71987	-0.34763	-0.00423	-0.00494	-0.01867	0.01640	0.00510	0.00840	-0.00028	0.01027	-0.01439	0.01307	0.00432	-0.00064	-0.02006	0.02208	-0.00420
50.At intersection crash	1.00000	-0.39366	-0.10829	0.00314	-0.23721	-0.01720	-0.01197	-0.00894	-0.00241	-0.02811	-0.00310	-0.03070	-0.06580	-0.07593	-0.05142	0.00148	0.03879
51.Off roadway crash	-0.39366	1.00000	0.14638	0.00136	0.34316	0.00115	0.00894	0.00124	0.00426	0.01969	0.02164	0.02375	0.08266	0.10095	0.09581	-0.02912	-0.04614
52.Dark	-0.10829	0.14638	1.00000	0.06475	0.09034	0.03198	0.00462	0.00094	-0.01630	0.03555	0.04666	0.02256	0.05298	0.06383	0.02012	-0.03845	-0.05562
53.Adverse conditions	0.00314	0.00136	0.06475	1.00000	-0.00634	0.26773	0.14556	0.04623	0.01801	0.25803	-0.00240	0.00282	-0.00203	-0.00777	0.00023	0.00877	-0.00643
54.Rural roads	-0.23721	0.34316	0.09034	-0.00634	1.00000	0.04946	0.01721	0.00241	0.00083	0.02829	0.03579	0.01179	0.09613	0.11131	0.06250	-0.01905	-0.03519
55.Animall factors	-0.01720	0.00115	0.03198	0.26773	0.04946	1.00000	-0.01522	-0.00652	0.03538	0.21815	0.00599	0.00110	-0.00990	-0.01185	-0.00145	0.00618	-0.00536
56.Weatherl factors	-0.01197	0.00894	0.00462	0.14556	0.01721	-0.01522	1.00000	-0.00398	0.00142	0.12509	0.00134	0.00433	-0.00550	-0.00995	-0.00846	0.00575	-0.00386
57.Vision obstruction	-0.00894	0.00124	0.00094	0.04623	0.00241	-0.00652	-0.00398	1.00000	0.04238	0.05756	0.00098	0.00432	0.00544	0.00216	0.01951	0.01368	-0.00387
58.Vehicle factors	-0.00241	0.00426	-0.01630	0.01801	0.00083	0.03538	0.00142	0.04238	1.00000	0.02679	0.00689	0.00761	0.00267	0.00142	-0.00774	-0.00892	-0.01029
59.Road factors	-0.02811	0.01969	0.03555	0.25803	0.02829	0.21815	0.12509	0.05756	0.02679	1.00000	0.01198	0.00404	-0.00172	0.00224	0.00904	0.00085	-0.01202
60.Passenger	-0.00310	0.02164	0.04666	-0.00240	0.03579	0.00599	0.00134	0.00098	0.00689	0.01198	1.00000	-0.49913	-0.10505	0.15110	0.03084	-0.52844	0.00811
61.Male driver	-0.03070	0.02375	0.02256	0.00282	0.01179	0.00110	0.00433	0.00432	0.00761	0.00404	-0.49913	1.00000	0.09495	-0.04639	0.00939	0.26376	-0.73703
62.Driver seatbelt not used	-0.06580	0.08266	0.05298	-0.00203	0.09613	-0.00990	-0.00550	0.00544	0.00267	-0.00172	-0.10505	0.09495	1.00000	0.55950	0.24271	0.05551	-0.04271
63.Seatbelt do not wear	-0.07593	0.10095	0.06383	-0.00777	0.11131	-0.01185	-0.00995	0.00216	0.00142	0.00224	0.15110	-0.04639	0.55950	1.00000	0.28734	-0.24742	-0.02515
64.Occupants Ejection	-0.05142	0.09581	0.02012	0.00023	0.06250	-0.00145	-0.00846	0.01951	-0.00774	0.00904	0.03084	0.00939	0.24271	0.28734	1.00000	-0.05881	-0.02573
65.Occupants Front Seat	0.00148	-0.02912	-0.03845	0.00877	-0.01905	0.00618	0.00575	0.01368	-0.00892	0.00085	-0.52844	0.26376	0.05551	-0.24742	-0.05881	1.00000	0.00853
66.Female occupants	0.03879	-0.04614	-0.05562	-0.00643	-0.03519	-0.00536	-0.00386	-0.00387	-0.01029	-0.01202	0.00811	-0.73703	-0.04271	-0.02515	-0.02573	0.00853	1.00000

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.4 Collinearity Matrix for Injury Severity Model of Young-Adult and their Passengers

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.Young-adult distracted by cell phone	1	-0.02091	-0.05278	-0.02812	-0.20853	0.00578	0.00977	0.08366	-0.00679	-0.00029	0.00925	-0.00401	0.01982	-0.02098	-0.01494	0.00301	0.05629
2.Young-adult distracted by other electronic devices	-0.02091	1	-0.03198	-0.01703	-0.12634	0.01917	0.00761	-0.0082	0.00193	0.01899	0.00548	-0.02148	0.00412	-0.00839	-0.01103	0.01033	0.03029
3.Young-adult distracted In/on-vehicle	-0.05278	-0.03198	1	-0.04299	-0.31888	0.02156	0.00922	-0.02914	0.01101	0.00519	-0.01731	0.00722	0.01706	-0.01539	-0.01171	-0.00249	0.07222
4.External distraction Young-adult	-0.02812	-0.01703	-0.04299	1	-0.16986	0.01309	0.01098	-0.03405	0.01505	-0.00348	0.00129	-0.00683	-0.00232	-0.00119	-0.00461	0.00434	-0.00594
5.Inattentive Young-adult	-0.20853	-0.12634	-0.31888	-0.16986	1	0.0279	0.01142	-0.03235	-0.00347	0.00524	-0.00611	0.00117	0.01295	-0.01872	0.00347	-0.02366	-0.08637
6.Valid licensed	0.00578	0.01917	0.02156	0.01309	0.0279	1	0.08208	-0.08043	0.06668	0.08182	0.00389	-0.10563	0.01688	-0.01986	0.02056	-0.02504	0.00053
7.Restricted license	0.00977	0.00761	0.00922	0.01098	0.01142	0.08208	1	-0.03937	0.01551	0.02798	-0.00903	-0.02105	0.02837	-0.00297	-0.04136	0.01225	-0.01202
8.Alchohol/drug related	0.08366	-0.0082	-0.02914	-0.03405	-0.03235	-0.08043	-0.03937	1	-0.00131	-0.01882	-0.00164	0.01868	-0.01372	-0.03324	0.0305	0.00204	0.06442
9.Vehicle age (Year 5 or newer)	-0.00679	0.00193	0.01101	0.01505	-0.00347	0.06668	0.01551	-0.00131	1	-0.14074	-0.19573	-0.2161	0.01049	-0.01476	-0.01619	0.00987	-0.02365
10.Vehicle age (6-10 years)	-0.00029	0.01899	0.00519	-0.00348	0.00524	0.08182	0.02798	-0.01882	-0.14074	1	-0.36494	-0.40293	0.02386	-0.02733	-0.01964	-0.0044	-0.01934
11.Vehicle age (11-15 years)	0.00925	0.00548	-0.01731	0.00129	-0.00611	0.00389	-0.00903	-0.00164	-0.19573	-0.36494	1	-0.56035	-0.03516	0.02157	-0.02924	0.06263	-0.0032
12.Vehicle age (Year 16 or older)	-0.00401	-0.02148	0.00722	-0.00683	0.00117	-0.10563	-0.02105	0.01868	-0.2161	-0.40293	-0.56035	1	0.01036	0.00961	0.05136	-0.06115	0.03266
13.Automobile	0.01982	0.00412	0.01706	-0.00232	0.01295	0.01688	0.02837	-0.01372	0.01049	0.02386	-0.03516	0.01036	1	-0.24743	-0.5777	-0.5677	0.03532
14.Van	-0.02098	-0.00839	-0.01539	-0.00119	-0.01872	-0.01986	-0.00297	-0.03324	-0.01476	-0.02733	0.02157	0.00961	-0.24743	1	-0.08664	-0.08514	-0.03706
15.Pickup-truck, camper-rv	-0.01494	-0.01103	-0.01171	-0.00461	0.00347	0.02056	-0.04136	0.0305	-0.01619	-0.01964	-0.02924	0.05136	-0.5777	-0.08664	1	-0.19878	-0.01074
16.Sport vehicle	0.00301	0.01033	-0.00249	0.00434	-0.02366	-0.02504	0.01225	0.00204	0.00987	-0.0044	0.06263	-0.06115	-0.5677	-0.08514	-0.19878	1	-0.01198
17.Straight-following maneuver	0.05629	0.03029	0.07222	-0.00594	-0.08637	0.00053	-0.01202	0.06442	-0.02365	-0.01934	-0.0032	0.03266	0.03532	-0.03706	-0.01074	-0.01198	1
18.Turn/changing lanes maneuver	-0.04431	-0.0197	-0.06432	0.01796	0.05704	-0.0059	0.00505	-0.04346	0.03503	0.02011	-0.00644	-0.02935	-0.00484	0.01109	-0.00762	0.00937	-0.67377
19.Avoiding maneuver	-0.00477	-0.00767	-0.00054	0.00261	-0.00089	0.00177	0.00806	-0.0169	-0.01544	-0.0127	0.03617	-0.01535	-0.00185	0.00371	0.00452	-0.01087	-0.27121
20.Stopped/parking/backing maneuver	-0.03061	-0.01984	-0.03309	-0.01384	0.06715	0.01735	0.01548	-0.05396	0.00453	0.02152	-0.01561	-0.00634	-0.04269	0.04069	0.02124	0.01054	-0.49342
21.No damage	-0.014	0.00302	-0.0077	0.00144	0.03361	0.01711	0.01699	-0.01789	0.00089	-0.00951	-0.00818	0.01123	-0.05229	-0.0065	0.06759	0.00157	-0.05021
22.Minor damage	-0.03724	-0.01779	-0.02716	0.00761	0.07086	0.01958	0.00302	-0.09634	0.01518	0.01111	-0.03065	0.01264	-0.09503	0.03368	0.06718	0.04288	-0.13454
23.Functional damage	-0.03685	-0.01161	-0.00925	0.01357	0.04713	0.02493	-0.00143	-0.09704	-0.00291	-0.00867	0.01997	-0.00907	0.04002	0.01121	-0.05286	0.00026	-0.05418
24.Disabling damage	0.05106	0.0241	0.0286	-0.00415	-0.05871	-0.0208	0.00336	0.06814	0.00248	0.01778	-0.00497	-0.01065	0.08689	-0.02636	-0.05605	-0.05015	0.13514
25.Destroyed damage	0.0379	0.00666	0.01	-0.02494	-0.10492	-0.03583	-0.00655	0.18933	-0.02734	-0.02623	0.0312	0.00552	-0.03814	-0.01735	0.03967	0.01859	0.09264
26.Speed limit<35 mph	-0.00177	-0.02479	-0.01266	-0.01289	0.04375	-0.04108	-0.01913	0.01218	-0.00837	0.00093	-0.01738	0.01995	-0.01235	0.03619	-0.00786	0.00283	-0.07747
27.Speed limit 35-60 mph	0.00842	0.02177	0.00869	0.03227	0.02768	0.01805	0.00471	-0.01857	-0.00751	-0.01854	-0.00074	0.02116	0.01553	-0.02695	-0.01183	0.00636	0.07114
28.Speed limit>60 mph	-0.005	-0.00041	0.00193	-0.02687	-0.09995	0.02794	0.02146	0.01279	0.02569	0.02331	0.01978	-0.05279	-0.00378	-0.01356	0.02671	-0.01255	0.01336
29.Concrete roads	-0.00469	-0.00878	-0.00875	0.03266	0.01268	-0.01038	0.00301	-0.02233	-0.01495	0.00097	0.01305	-0.00578	0.01104	-0.00859	-0.00639	-0.0047	0.01542
30.Black top roads	0.00554	0.01339	0.01688	-0.02708	-0.00897	0.01495	-0.00851	-0.01306	0.0176	0.00756	-0.01202	-0.00294	0.02944	0.01118	-0.04083	-0.00274	-0.01671
31.Gravel/brick roads	-0.003	-0.01064	-0.01772	-0.01031	-0.00624	-0.006	0.01341	0.07564	-0.00617	-0.0218	0.00159	0.01806	-0.08991	-0.00576	0.10453	0.01667	0.00618
32.Wet/debris roads	-0.02161	-0.0096	-0.03125	-0.01971	0.02742	0.00343	0.00588	-0.0053	-0.01768	-0.01876	-0.00087	0.02724	0.00796	-0.00039	0.00521	-0.01002	-0.00538
33.Curved road	0.01584	-0.00997	-0.00774	-0.01215	-0.03162	-0.00121	-0.00288	0.03303	0.00051	0.003	0.02596	-0.0293	-0.01563	-0.01815	0.02326	-0.00523	0.0197
34.Work zone related	-0.00834	0.00154	-0.01696	0.0035	0.00578	0.02159	0.00169	-0.02124	-0.00817	0.01013	0.01352	-0.01869	0.00671	-0.00048	-0.00999	0.00231	-0.00701
35.Multi lanes road	0.00272	0.00993	0.01412	0.01134	-0.02661	0.00332	0.01082	0.01372	0.01099	-0.00503	0.00502	-0.00539	0.0384	-0.00543	-0.02074	-0.02208	0.03241
36.5.00-9.00-morning	-0.01147	-0.00677	-0.01109	0.00446	0.01556	0.01105	-0.00078	-0.04318	0.00309	0.03143	-0.00017	-0.02819	-0.00486	0.00283	0.00535	0.00274	0.01442
37.9.00-13.00-noon	-0.02391	0.00384	0.00988	0.01302	0.02964	0.03755	0.00872	-0.09936	0.00644	0.00633	-0.00498	-0.00536	-0.02421	0.03534	0.00717	0.00782	-0.0234
38.13.00-17.00-afternoon	-0.03304	-0.01235	0.00652	0.00282	0.01939	0.00201	0.01261	-0.13805	-0.01643	-0.02285	0.01084	0.01861	-0.01852	0.03301	0.00747	0.00219	-0.02902
39.17.00-21.00-evening	-0.01256	0.01703	0.01888	0.0128	0.00977	0.00447	0.01292	-0.04643	0.01179	-0.00542	-0.01205	0.00935	0.02696	-0.02194	-0.03537	0.00582	-0.01413
40.21.00-5.00-night	0.0902	-0.00253	-0.02876	-0.03471	-0.07928	-0.05625	-0.03942	0.36243	-0.00154	0.00042	0.00372	-0.00215	0.02264	-0.05508	0.01781	-0.02039	0.06194
41.Weekend	0.01053	0.01529	-0.0182	-0.01669	-0.08062	-0.02888	-0.03223	0.14518	0.00096	0.02305	-0.00174	-0.01848	0.01189	-0.02113	0.0002	-0.00878	0.02215
42.Head On crash	0.00306	-0.01043	-0.01631	-0.00454	0.00371	-0.00178	-0.00685	0.01108	0.00087	-0.00721	0.00249	0.00305	0.00829	0.00365	-0.00366	-0.00912	-0.07787
43.Rear end crash	-0.02959	0.01987	0.03413	0.06626	0.09159	0.0585	0.01282	-0.15462	-0.00698	-0.00032	-0.00287	0.00663	0.05925	-0.01441	-0.07598	0.01762	0.20861
44.Angle crash	-0.01519	-0.01349	-0.03303	-0.03127	0.03654	0.00414	0.00717	-0.07551	0.00275	0.01477	-0.01848	0.00437	0.00964	0.00114	0.00269	-0.01071	-0.1685
45.Opposite direction crash	-0.00525	0.0021	-0.00444	-0.002	-0.01126	0.00767	0.00475	-0.00112	-0.00065	-0.00309	0.0147	-0.01178	-0.01938	-0.00365	0.02604	0.00376	-0.03238
46.Same direction crash	-0.02746	-0.0057	-0.02914	-0.01355	0.0165	0.01477	0.00469	-0.03291	0.02841	-0.0045	-0.01285	-0.00054	-0.00381	0.01307	0.00423	-0.00424	-0.21403
47.Backed into crash	-0.01864	-0.01031	-0.02763	-0.01025	0.02697	-0.00898	0.00719	-0.0214	0.00308	0.024	-0.02045	-0.00188	-0.05203	0.03718	0.05239	-0.00246	-0.17857
48.Single-vehicle crash	0.0479	-0.00098	0.01171	-0.03619	-0.13735	-0.04923	-0.01531	0.20704	0.00595	-0.00555	0.01478	-0.01279	-0.00243	-0.03241	0.0339	-0.01477	0.08432
49.On roadway crash	-0.01283	-0.0003	-0.00174	0.00457	0.02605	-0.00157	-0.00223	-0.00045	-0.02703	-0.00692	0.00314	0.01617	-0.00321	0.02517	-0.00522	-0.00861	-0.02273
50.At intersection crash	-0.01235	0.00514	-0.00486	0.0109	0.06765	0.02483	0.01244	-0.12603	0.00794	0.01195	-0.00982	-0.00393	0.02849	-0.01456	-0.03556	0.011	-0.03628
51.Off roadway crash	0.03587	-0.0073	0.00929	-0.02149	-0.13219	-0.03116	-0.0152	0.17443	0.02475	-0.00648	0.00927	-0.01625	-0.03307	-0.01507	0.05626	-0.00584	0.08349
52.Dark	0.07544	0.00536	-0.02032	-0.02866	-0.07325	-0.05664	-0.02551	0.30394	0.02164	0.00592	-0.0063	-0.01	0.03376	-0.05544	0.0035	-0.018	0.04338
53.Adverse conditions	-0.0109	-0.00828	-0.03256	-0.0104	0.01842	-0.00441	0.01241	0.00728	-0.00736	-0.02183	0.00374	0.01976	0.00765	-0.01077	0.00243	-0.00183	0.00049
54.Rural roads	0.00578	-0.00554	0.01092	-0.03139	-0.10352	0.03139	0.01076	0.07278	0.01882	-0.01719	0.02409	-0.01927	-0.1199	-0.02095	0.15678	0.00582	0.03702
55.Animall factors	-0.01597	-0.00215	-0.01863	0.01865	0.01765	0.02603	0.00806	-0.02179	-0.01497	0.00315	0.00235	0.00252	-0.00267	0.00902	-0.00601	0.00743	-0.00853
56.Weatherl factors	-0.0144	-0.00021	-0.02034	0.00926	0.01541	-0.0042	0.00618	-0.00972	0.01725	-0.00701	0.00139	-0.00396	0.00663	-0.00575	0.01024	-0.01362	0.00648
57.Vision obstruction	-0.00025	0.00733	-0.00666	0.00275	0.00461	-0.00354	0.00591	-0.01055	-0.00613	0.01167	-0.00968	0.00316	-0.00357	-0.00795	0.01347	-0.00384	0.0116
58.Vehicle factors	-0.00757	-0.00916	0.00268	-0.01232	0.00697	-0.01428	-0.0142	-0.02081	-0.0144	-0.02164	-0.01062	0.03509	-0.0038	0.00258	0.02142	-0.01947	0.00244
59.Road factors	-0.01369	0.00818	-0.01081	-0.00048	0.00568	0.00098	-0.00495	-0.00252	0.00159	0.00132	-0.00007	-0.0019	-0.00739	0.00683	0.00559	-0.00156	-0.00558
60.Passenger	-0.10667	-0.06463	-0.16312	-0.08689	-0.54444	-0.05908	-0.03128	0.0052	-0.01348	-0.01696	0.01881	0.00397	-0.02622	0.04745	-0.00549	0.02738	-0.02192
61.Male driver	0.03564	0.04169	0.05679	0.04499	0.30075	-0.01119	-0.05552	0.06019	-0.01324	-0.05156	-0.03981	0.08802	-0.09454	-0.02334	0.20447	-0.09396	0.01835
62.Driver seatbelt not used	0.04069	0.00059	0.02566	-0.00134	0.04148	-0.03983	-0.00855	0.13911	-0.02256	-0.01527	-0.00423	0.02588	-0.07797	-0.02317	0.04733	-0.0313	0.03483
63.Seatbelt do not wear	-0.02395	-0.02861	-0.05804	-0.03971	-0.2644	-0.05958	-0.01526	0.07004	-0.03154	-0.01303	0.0187	0.00786	-0.08539	0.02776	0.02284	0.02076	0.04885
64.Occupants Ejection	0.0016	-0.01076	-0.00732	-0.01055	0.00118	-0.0328	-0.00644	0.08903	-0.01266	0.00243	0.01281	-0.012	-0.08095	-0.01841	0.03134	0.00319	0.0302
65.Occupants Front Seat	0.06936	0.04202	0.10606	0.0565	0.41901	0.04806	0.01573	0.02635	0.01537	0.00427	-0.02324	0.01101	0.02827	-0.06334	0.03628	-0.04789	-0.00491
66.Female occupants	0.01404	-0.0115	0.01878	-0.00446	-0.00223	0.03851	0.07244	-0.06685	0.01205	0.05833	0.03459	-0.08852	0.11477	0.00143	-0.2149	0.08412	-0.01154

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.4 (continued)

Variable	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1.Young-adult distracted by cell phone	-0.04431	-0.00477	-0.03061	-0.014	-0.03724	-0.03685	0.05106	0.0379	-0.00177	0.00842	-0.005	-0.00469	0.00554	-0.003	-0.02161	0.01584
2.Young-adult distracted by other electronic devices	-0.0197	-0.00767	-0.01984	0.00302	-0.01779	-0.01161	0.0241	0.00666	-0.02479	0.02177	-0.00041	-0.00878	0.01339	-0.01064	-0.0096	-0.00997
3.Young-adult distracted In/on-vehicle	-0.06432	-0.00054	-0.03309	-0.0077	-0.02716	-0.00925	0.0286	0.01	-0.01266	0.00869	0.00193	-0.00875	0.01688	-0.01772	-0.03125	-0.00774
4.External distraction Young-adult	0.01796	0.00261	-0.01384	0.00144	0.00761	0.01357	-0.00415	-0.02494	-0.01289	0.03227	-0.02687	0.03266	-0.02708	-0.01031	-0.01971	-0.01215
5.Inattentive Young-adult	0.05704	-0.00089	0.06715	0.03361	0.07086	0.04713	-0.05871	-0.10492	0.04375	0.02768	-0.09995	0.01268	-0.00897	-0.00624	0.02742	-0.03162
6.Valid licensed	-0.0059	0.00177	0.01735	0.01711	0.01958	0.02493	-0.0208	-0.03583	-0.04108	0.01805	0.02794	-0.01038	0.01495	-0.006	0.00343	-0.00121
7.Restricted license	0.00505	0.00806	0.01548	0.01699	0.00302	-0.00143	0.00336	-0.00655	-0.01913	0.00471	0.02146	0.00301	-0.00851	0.01341	0.00588	-0.00288
8.Alchohol/drug related	-0.04346	-0.0169	-0.05396	-0.01789	-0.09634	-0.09704	0.06814	0.18933	0.01218	-0.01857	0.01279	-0.02233	-0.01306	0.07564	-0.0053	0.03303
9.Vehicle age (Year 5 or newer)	0.03503	-0.01544	0.00453	0.00089	0.01518	-0.00291	0.00248	-0.02734	-0.00837	-0.00751	0.02569	-0.01495	0.0176	-0.00617	-0.01768	0.00051
10.Vehicle age (6-10 years)	0.02011	-0.0127	0.02152	-0.00951	0.01111	-0.00867	0.01778	-0.02623	0.00093	-0.01854	0.02331	0.00097	0.00756	-0.0218	-0.01876	0.003
11.Vehicle age (11-15 years)	-0.00644	0.03617	-0.01561	-0.00818	-0.03065	0.01997	-0.00497	0.0312	-0.01738	-0.00074	0.01978	0.01305	-0.01202	0.00159	-0.00087	0.02596
12.Vehicle age (Year 16 or older)	-0.02935	-0.01535	-0.00634	0.01123	0.01264	-0.00907	-0.01065	0.00552	0.01995	0.02116	-0.05279	-0.00578	-0.00294	0.01806	0.02724	-0.0293
13.Automobile	-0.00484	-0.00185	-0.04269	-0.05229	-0.09503	0.04002	0.08689	-0.03814	-0.01235	0.01553	-0.00378	0.01104	0.02944	-0.08991	0.00796	-0.01563
14.Van	0.01109	0.00371	0.04069	-0.0065	0.03368	0.01121	-0.02636	-0.01735	0.03619	-0.02695	-0.01356	-0.00859	0.01118	-0.00576	-0.00039	-0.01815
15.Pickup-truck, camper-rv	-0.00762	0.00452	0.02124	0.06759	0.06718	-0.05286	-0.05605	0.03967	-0.00786	-0.01183	0.02671	-0.00639	-0.04083	0.10453	0.00521	0.02326
16.Sport vehicle	0.00937	-0.01087	0.01054	0.00157	0.04288	0.00026	-0.05015	0.01859	0.00283	0.00636	-0.01255	-0.0047	-0.00274	0.01667	-0.01002	-0.00523
17.Straight-following maneuver	-0.67377	-0.27121	-0.49342	-0.05021	-0.13454	-0.05418	0.13514	0.09264	-0.07747	0.07114	0.01336	0.01542	-0.01671	0.00618	-0.00538	0.0197
18.Turn/changing lanes maneuver	1	-0.07413	-0.13486	-0.00445	0.0492	0.06089	-0.05815	-0.06649	0.03786	-0.02524	-0.01579	0.01341	0.00157	-0.03521	0.00811	-0.00079
19.Avoiding maneuver	-0.07413	1	-0.05429	-0.01873	-0.03905	0.00614	0.01998	0.02684	-0.05849	-0.0154	0.09904	-0.00935	-0.00376	0.02905	-0.00037	0.00519
20.Stopped/parking/backing maneuver	-0.13486	-0.05429	1	0.0958	0.17945	0.01004	-0.15067	-0.08439	0.10331	-0.06028	-0.06421	-0.03185	0.02311	0.01683	-0.00579	-0.03984
21.No damage	-0.00445	-0.01873	0.0958	1	-0.07644	-0.08787	-0.1011	-0.04257	0.041	-0.02117	-0.03565	0.00164	-0.00181	0.00114	-0.0125	-0.01867
22.Minor damage	0.0492	-0.03905	0.17945	-0.07644	1	-0.35976	-0.41395	-0.17428	0.08527	-0.00111	-0.11646	0.00597	0.01069	-0.03712	-0.00981	-0.05584
23.Functional damage	0.06089	0.00614	0.01004	-0.08787	-0.35976	1	-0.4758	-0.20032	0.06771	-0.00514	-0.08179	0.01031	0.00717	-0.03796	0.02824	-0.04764
24.Disabling damage	-0.05815	0.01998	-0.15067	-0.1011	-0.41395	-0.4758	1	-0.2305	-0.08726	0.01449	0.09931	0.00747	-0.00971	0.00682	-0.00168	0.03223
25.Destroyed damage	-0.06649	0.02684	-0.08439	-0.04257	-0.17428	-0.20032	-0.2305	1	-0.1091	-0.00226	0.15575	-0.03849	-0.00994	0.10372	-0.02404	0.11009
26.Speed limit<35 mph	0.03786	-0.05849	0.10331	0.041	0.08527	0.06771	-0.08726	-0.1091	1	-0.71684	-0.29138	-0.06991	0.07347	-0.01723	-0.00139	-0.06125
27.Speed limit 35-60 mph	-0.02524	-0.0154	-0.06028	-0.02117	-0.00111	-0.00514	0.01449	-0.00226	-0.71684	1	-0.42068	0.01112	-0.0434	0.07444	-0.00368	-0.01271
28.Speed limit>60 mph	-0.01579	0.09904	-0.06421	-0.03565	-0.11646	-0.08179	0.09931	0.15575	-0.29138	-0.42068	1	0.07833	-0.03591	-0.08577	0.00851	0.09434
29.Concrete roads	0.01341	-0.00935	-0.03185	0.00164	0.00597	0.01031	0.00747	-0.03849	-0.06991	0.01112	0.07833	1	-0.89372	-0.13584	-0.00934	-0.01137
30.Black top roads	0.00157	-0.00376	0.02311	-0.00181	0.01069	0.00717	-0.00971	-0.00994	0.07347	-0.0434	-0.03591	-0.89372	1	-0.31833	0.00303	-0.00752
31.Gravel/brick roads	-0.03521	0.02905	0.01683	0.00114	-0.03712	-0.03796	0.00682	0.10372	-0.01723	0.07444	-0.08577	-0.13584	-0.31833	1	0.01487	0.04141
32.Wet/debris roads	0.00811	-0.00037	-0.00579	-0.0125	-0.00981	0.02824	-0.00168	-0.02404	-0.00139	-0.00368	0.00851	-0.00934	0.00303	0.01487	1	0.00199
33.Curved road	-0.00079	0.00519	-0.03984	-0.01867	-0.05584	-0.04764	0.03223	0.11009	-0.06125	-0.01271	0.09434	-0.01137	-0.00752	0.04141	0.00199	1
34.Work zone related	-0.01068	0.02165	0.01459	-0.00208	-0.00858	0.01421	0.00355	-0.01048	-0.07765	0.05521	0.02458	0.06198	-0.04405	-0.03305	-0.01936	-0.00256
35.Multi lanes road	-0.00268	0.01622	-0.0536	-0.05909	-0.01564	0.00561	0.01988	0.00389	-0.06206	0.07687	0.00387	-0.00235	0.05286	-0.10426	0.00344	-0.09354
36.5.00-9.00-morning	-0.00725	-0.00963	-0.0081	-0.01671	-0.02812	-0.00329	0.01901	0.0278	-0.05277	-0.02125	0.10198	0.02808	-0.02049	-0.01469	0.02416	0.03407
37.9.00-13.00-noon	0.02402	-0.01609	0.01985	0.02726	0.03154	0.0231	-0.03653	-0.0361	0.01786	0.01371	-0.03646	-0.00273	0.01361	-0.02247	0.00712	-0.02571
38.13.00-17.00-afternoon	0.01123	0.00461	0.04024	0.01937	0.06788	0.05163	-0.06357	-0.08434	0.01716	0.02946	-0.06443	-0.00233	0.01673	-0.03226	-0.0391	-0.04479
39.17.00-21.00-evening	0.0074	0.01864	0.0051	-0.00415	0.0303	0.01581	-0.01283	-0.04703	-0.02562	0.03399	-0.02103	0.00566	0.00465	-0.0213	-0.01548	-0.03822
40.21.00-5.00-night	-0.03954	-0.0007	-0.0682	-0.03135	-0.1229	-0.10283	0.11345	0.16607	0.03685	-0.0684	0.04697	-0.02819	-0.01854	0.09846	0.03494	0.09272
41.Weekend	-0.02319	-0.00257	-0.02378	-0.02311	-0.05727	-0.04346	0.04242	0.08874	-0.0058	-0.02944	0.0475	-0.03103	0.00684	0.05228	0.0141	0.04198
42.Head On crash	0.10804	0.01183	-0.02635	-0.01744	-0.03447	-0.01289	0.0308	0.03258	0.02332	-0.01006	-0.01688	-0.01429	0.01249	-0.00099	-0.01147	0.01216
43.Rear end crash	-0.24997	-0.05435	0.04358	0.0203	0.12342	0.09742	-0.09807	-0.18159	-0.20118	0.2504	-0.07966	0.08184	0.00145	-0.17564	-0.02004	-0.14237
44.Angle crash	0.29759	-0.02334	-0.08706	-0.03983	-0.01276	0.05417	0.00353	-0.0501	0.14977	-0.0552	-0.11988	-0.02068	0.03219	-0.03016	0.01883	-0.06908
45.Opposite direction crash	0.03925	0.0065	-0.01703	-0.00287	0.00902	-0.01454	0.00527	-0.00376	-0.00076	-0.02165	0.0269	-0.01437	0.00103	0.0288	0.01799	0.04905
46.Same direction crash	0.27683	0.06409	-0.04944	-0.01225	0.09543	0.04022	-0.09256	-0.04499	-0.01286	-0.03058	0.06291	0.01488	0.00105	-0.03308	0.00881	-0.0232
47.Backed into crash	-0.04952	-0.02189	0.36169	0.07125	0.09536	-0.00024	-0.0864	-0.03948	0.13779	-0.09547	-0.0524	-0.02019	0.00101	0.04133	-0.02529	-0.0311
48.Single-vehicle crash	-0.05994	0.04676	-0.11708	-0.04778	-0.19135	-0.13456	0.18012	0.21719	-0.09294	-0.04332	0.18142	-0.03254	-0.0468	0.17374	0.03621	0.2259
49.On roadway crash	-0.03745	0.0017	0.08258	-0.00869	0.02452	0.01796	-0.01193	-0.03382	0.13246	-0.09399	-0.03908	-0.01595	0.01266	0.00769	-0.01675	-0.05367
50.At intersection crash	0.09467	-0.03807	-0.02199	0.02789	0.09426	0.08102	-0.07432	-0.15969	-0.03923	0.13732	-0.13521	0.06306	0.00282	-0.14228	0.00287	-0.07625
51.Off roadway crash	-0.07979	0.05107	-0.08628	-0.03092	-0.16752	-0.1394	0.12222	0.27341	-0.1321	-0.06045	0.24856	-0.06402	-0.01796	0.17605	0.01814	0.17893
52.Dark	-0.02392	-0.00036	-0.05789	-0.03907	-0.10418	-0.09773	0.10667	0.14771	-0.00139	-0.03943	0.05241	-0.02291	-0.01508	0.0823	0.06735	0.08255
53.Adverse conditions	0.00114	-0.00202	-0.00954	-0.00714	-0.03193	0.01713	0.01536	-0.00207	-0.02369	-0.00188	0.03576	0.00156	0.0063	-0.01769	0.76242	0.00974
54.Rural roads	-0.05176	0.05871	-0.03258	-0.02489	-0.11695	-0.10965	0.07456	0.23601	-0.19637	0.01676	0.24334	-0.14335	-0.00359	0.31565	0.00412	0.09848
55.Animall factors	0.00621	0.03536	-0.017	0.00178	-0.01589	0.00169	0.01574	-0.00144	-0.03038	-0.00063	0.04457	-0.01838	0.00882	0.02022	0.21203	0.03365
56.Weatherl factors	-0.01343	0.01486	-0.0054	-0.00429	-0.01485	-0.01241	0.02113	0.00735	0.00609	-0.03719	0.04654	0.01955	-0.02159	0.00688	0.13694	0.00403
57.Vision obstruction	-0.01771	0.00875	0.00099	-0.00564	-0.01059	-0.01191	0.00845	0.01997	0.00768	-0.0127	0.00933	0.00429	0.00005	-0.00908	0.05943	0.01103
58.Vehicle factors	-0.00498	-0.00193	0.00288	-0.01112	-0.0153	-0.00463	0.01922	0.00092	0.00027	-0.00683	0.00668	0.0165	-0.01338	-0.00497	0.01305	-0.0081
59.Road factors	-0.01313	0.02598	0.00923	-0.00369	-0.01306	-0.01384	0.02126	0.00815	-0.05843	0.01288	0.06531	0.0083	-0.02076	0.02943	0.31225	0.02677
60.Passenger	0.02959	0.00689	-0.00138	-0.01498	-0.00149	0.00567	-0.01472	0.0279	0.01917	-0.02689	0.01593	-0.0163	0.0049	0.02331	0.01964	0.01641
61.Male driver	-0.01644	-0.00012	-0.0173	0.03023	-0.00773	-0.02698	0.0045	0.0295	-0.01923	-0.00017	0.02203	0.01199	-0.01978	0.01868	-0.00612	0.02314
62.Driver seatbelt not used	-0.03781	0.01308	-0.02495	-0.00606	-0.07306	-0.07343	0.05192	0.14368	-0.02883	0.00655	0.03122	-0.03289	0.00826	0.05256	-0.02361	0.04322
63.Seatbelt do not wear	-0.03798	0.00309	-0.03	-0.01627	-0.0451	-0.04713	0.02745	0.10879	-0.00823	0.00025	0.01605	-0.03904	0.01818	0.04271	-0.03141	0.03201
64.Occupants Ejection	-0.02024	-0.01306	-0.01586	-0.00442	-0.04124	-0.04746	-0.00045	0.14364	-0.0329	0.00589	0.03922	-0.02275	0.0004	0.048	-0.00926	0.05317
65.Occupants Front Seat	0.00307	0.00058	-0.00096	0.0123	-0.0089	-0.00697	0.01772	-0.01523	-0.01937	0.0173	-0.00214	0.02	-0.01659	-0.00489	-0.00316	-0.00878
66.Female occupants	0.00608	-0.0052	0.01951	-0.02334	0.00387	0.03536	0.00446	-0.05489	0.01107	0.01746	-0.03904	-0.00152	0.01597	-0.03316	0.001	-0.04031

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.4 (continued)

Variable	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
1.Young-adult distracted by cell phone	-0.00834	0.00272	-0.01147	-0.02391	-0.03304	-0.01256	0.0902	0.01053	0.00306	-0.02959	-0.01519	-0.00525	-0.02746	-0.01864	0.0479	-0.01283
2.Young-adult distracted by other electronic devices	0.00154	0.00993	-0.00677	0.00384	-0.01235	0.01703	-0.00253	0.01529	-0.01043	0.01987	-0.01349	0.0021	-0.0057	-0.01031	-0.00098	-0.0003
3.Young-adult distracted In/on-vehicle	-0.01696	0.01412	-0.01109	0.00988	0.00652	0.01888	-0.02876	-0.0182	-0.01631	0.03413	-0.03303	-0.00444	-0.02914	-0.02763	0.01171	-0.00174
4.External distraction Young-adult	0.0035	0.01134	0.00446	0.01302	0.00282	0.0128	-0.03471	-0.01669	-0.00454	0.06626	-0.03127	-0.002	-0.01355	-0.01025	-0.03619	0.00457
5.Inattentive Young-adult	0.00578	-0.02661	0.01556	0.02964	0.01939	0.00977	-0.07928	-0.08062	0.00371	0.09159	0.03654	-0.01126	0.0165	0.02697	-0.13735	0.02605
6.Valid licensed	0.02159	0.00332	0.01105	0.03755	0.00201	0.00447	-0.05625	-0.02888	-0.00178	0.0585	0.00414	0.00767	0.01477	-0.00898	-0.04923	-0.00157
7.Restricted license	0.00169	0.01082	-0.00078	0.00872	0.01261	0.01292	-0.03942	-0.03223	-0.00685	0.01282	0.00717	0.00475	0.00469	0.00719	-0.01531	-0.00223
8.Alchohol/drug related	-0.02124	0.01372	-0.04318	-0.09936	-0.13805	-0.04643	0.36243	0.14518	0.01108	-0.15462	-0.07551	-0.00112	-0.03291	-0.0214	0.20704	-0.00045
9.Vehicle age (Year 5 or newer)	-0.00817	0.01099	0.00309	0.00644	-0.01643	0.01179	-0.00154	0.00096	0.00087	-0.00698	0.00275	-0.00065	0.02841	0.00308	0.00595	-0.02703
10.Vehicle age (6-10 years)	0.01013	-0.00503	0.03143	0.00633	-0.02285	-0.00542	0.00042	0.02305	-0.00721	-0.00032	0.01477	-0.00309	-0.0045	0.024	-0.00555	-0.00692
11.Vehicle age (11-15 years)	0.01352	0.00502	-0.00017	-0.00498	0.01084	-0.01205	0.00372	-0.00174	0.00249	-0.00287	-0.01848	0.0147	-0.01285	-0.02045	0.01478	0.00314
12.Vehicle age (Year 16 or older)	-0.01869	-0.00539	-0.02819	-0.00536	0.01861	0.00935	-0.00215	-0.01848	0.00305	0.00663	0.00437	-0.01178	-0.00054	-0.00188	-0.01279	0.01617
13.Automobile	0.00671	0.0384	-0.00486	-0.02421	-0.01852	0.02696	0.02264	0.01189	0.00829	0.05925	0.00964	-0.01938	-0.00381	-0.05203	-0.00243	-0.00321
14.Van	-0.00048	-0.00543	0.00283	0.03534	0.03301	-0.02194	-0.05508	-0.02113	0.00365	-0.01441	0.00114	-0.00365	0.01307	0.03718	-0.03241	0.02517
15.Pickup-truck, camper-rv	-0.00999	-0.02074	0.00535	0.00717	0.00747	-0.03537	0.01781	0.0002	-0.00366	-0.07598	0.00269	0.02604	0.00423	0.05239	0.0339	-0.00522
16.Sport vehicle	0.00231	-0.02208	0.00274	0.00782	0.00219	0.00582	-0.02039	-0.00878	-0.00912	0.01762	-0.01071	0.00376	-0.00424	-0.00246	-0.01477	-0.00861
17.Straight-following maneuver	-0.00701	0.03241	0.01442	-0.0234	-0.02902	-0.01413	0.06194	0.02215	-0.07787	0.20861	-0.1685	-0.03238	-0.21403	-0.17857	0.08432	-0.02273
18.Turn/changing lanes maneuver	-0.01068	-0.00268	-0.00725	0.02402	0.01123	0.0074	-0.03954	-0.02319	0.10804	-0.24997	0.29759	0.03925	0.27683	-0.04952	-0.05994	-0.03745
19.Avoiding maneuver	0.02165	0.01622	-0.00963	-0.01609	0.00461	0.01864	-0.0007	-0.00257	0.01183	-0.05435	-0.02334	0.0065	0.06409	-0.02189	0.04676	0.0017
20.Stopped/parking/backing maneuver	0.01459	-0.0536	-0.0081	0.01985	0.04024	0.0051	-0.0682	-0.02378	-0.02635	0.04358	-0.08706	-0.01703	-0.04944	0.36169	-0.11708	0.08258
21.No damage	-0.00208	-0.05909	-0.01671	0.02726	0.01937	-0.00415	-0.03135	-0.02311	-0.01744	0.0203	-0.03983	-0.00287	-0.01225	0.07125	-0.04778	-0.00869
22.Minor damage	-0.00858	-0.01564	-0.02812	0.03154	0.06788	0.0303	-0.1229	-0.05727	-0.03447	0.12342	-0.01276	0.00902	0.09543	0.09536	-0.19135	0.02452
23.Functional damage	0.01421	0.00561	-0.00329	0.0231	0.05163	0.01581	-0.10283	-0.04346	-0.01289	0.09742	0.05417	-0.01454	0.04022	-0.00024	-0.13456	0.01796
24.Disabling damage	0.00355	0.01988	0.01901	-0.03653	-0.06357	-0.01283	0.11345	0.04242	0.0308	-0.09807	0.00353	0.00527	-0.09256	-0.0864	0.18012	-0.01193
25.Destroyed damage	-0.01048	0.00389	0.0278	-0.0361	-0.08434	-0.04703	0.16607	0.08874	0.03258	-0.18159	-0.0501	-0.00376	-0.04499	-0.03948	0.21719	-0.03382
26.Speed limit<35 mph	-0.07765	-0.06206	-0.05277	0.01786	0.01716	-0.02562	0.03685	-0.0058	0.02332	-0.20118	0.14977	-0.00076	-0.01286	0.13779	-0.09294	0.13246
27.Speed limit 35-60 mph	0.05521	0.07687	-0.02125	0.01371	0.02946	0.03399	-0.0684	-0.02944	-0.01006	0.2504	-0.0552	-0.02165	-0.03058	-0.09547	-0.04332	-0.09399
28.Speed limit>60 mph	0.02458	0.00387	0.10198	-0.03646	-0.06443	-0.02103	0.04697	0.0475	-0.01688	-0.07966	-0.11988	0.0269	0.06291	-0.0524	0.18142	-0.03908
29.Concrete roads	0.06198	-0.00235	0.02808	-0.00273	-0.00233	0.00566	-0.02819	-0.03103	-0.01429	0.08184	-0.02068	-0.01437	0.01488	-0.02019	-0.03254	-0.01595
30.Black top roads	-0.04405	0.05286	-0.02049	0.01361	0.01673	0.00465	-0.01854	0.00684	0.01249	0.00145	0.03219	0.00103	0.00105	0.00101	-0.0468	0.01266
31.Gravel/brick roads	-0.03305	-0.10426	-0.01469	-0.02247	-0.03226	-0.0213	0.09846	0.05228	-0.00099	-0.17564	-0.03016	0.0288	-0.03308	0.04133	0.17374	0.00769
32.Wet/debris roads	-0.01936	0.00344	0.02416	0.00712	-0.0391	-0.01548	0.03494	0.0141	-0.01147	-0.02004	0.01883	0.01799	0.00881	-0.02529	0.03621	-0.01675
33.Curved road	-0.00256	-0.09354	0.03407	-0.02571	-0.04479	-0.03822	0.09272	0.04198	0.01216	-0.14237	-0.06908	0.04905	-0.0232	-0.0311	0.2259	-0.05367
34.Work zone related	1	-0.01879	0.0099	0.02477	-0.00247	-0.01055	-0.01902	-0.03791	-0.01115	0.06987	-0.03768	-0.01661	0.01898	-0.01833	-0.02474	0.01748
35.Multi lanes road	-0.01879	1	-0.01938	0.01926	0.0034	0.02248	-0.0318	0.00932	0.0054	0.06099	0.01624	0.01336	0.01692	-0.03355	-0.03792	-0.00737
36.5.00-9.00-morning	0.0099	-0.01938	1	-0.18198	-0.2583	-0.21075	-0.17609	-0.08835	-0.0119	-0.02002	-0.01368	0.01154	-0.01922	-0.00742	0.04234	-0.00712
37.9.00-13.00-noon	0.02477	0.01926	-0.18198	1	-0.30234	-0.24667	-0.20611	-0.01412	-0.00032	0.03762	0.03653	0.00161	0.01513	0.01206	-0.06382	0.00082
38.13.00-17.00-afternoon	-0.00247	0.0034	-0.2583	-0.30234	1	-0.35013	-0.29255	-0.06072	0.00221	0.12186	0.0426	0.00881	0.02476	0.03889	-0.14804	0.00318
39.17.00-21.00-evening	-0.01055	0.02248	-0.21075	-0.24667	-0.35013	1	-0.23869	-0.03039	-0.00934	0.08794	0.01043	-0.01547	0.00198	-0.01269	-0.08555	-0.01003
40.21.00-5.00-night	-0.01902	-0.0318	-0.17609	-0.20611	-0.29255	-0.23869	1	0.20346	0.01931	-0.26679	-0.08927	-0.00549	-0.02989	-0.04005	0.30253	0.0141
41.Weekend	-0.03791	0.00932	-0.08835	-0.01412	-0.06072	-0.03039	0.20346	1	-0.0079	-0.13704	-0.02936	0.01036	-0.00566	-0.00793	0.14061	-0.00079
42.Head On crash	-0.01115	0.0054	-0.0119	-0.00032	0.00221	-0.00934	0.01931	-0.0079	1	-0.11683	-0.05419	-0.01358	-0.02791	-0.01617	-0.06043	0.01249
43.Rear end crash	0.06987	0.06099	-0.02002	0.03762	0.12186	0.08794	-0.26679	-0.13704	-0.11683	1	-0.38875	-0.09741	-0.20024	-0.11601	-0.43353	-0.00197
44.Angle crash	-0.03768	0.01624	-0.01368	0.03653	0.0426	0.01043	-0.08927	-0.02936	-0.05419	-0.38875	1	-0.04518	-0.09288	-0.05381	-0.20109	-0.15003
45.Opposite direction crash	-0.01661	0.01336	0.01154	0.00161	0.00881	-0.01547	-0.00549	0.01036	-0.01358	-0.09741	-0.04518	1	-0.02327	-0.01348	-0.05039	0.06424
46.Same direction crash	0.01898	0.01692	-0.01922	0.01513	0.02476	0.00198	-0.02989	-0.00566	-0.02791	-0.20024	-0.09288	-0.02327	1	-0.02772	-0.10358	0.07545
47.Backed into crash	-0.01833	-0.03355	-0.00742	0.01206	0.03889	-0.01269	-0.04005	-0.00793	-0.01617	-0.11601	-0.05381	-0.01348	-0.02772	1	-0.06001	0.0781
48.Single-vehicle crash	-0.02474	-0.03792	0.04234	-0.06382	-0.14804	-0.08555	0.30253	0.14061	-0.06043	-0.43353	-0.20109	-0.05039	-0.10358	-0.06001	1	-0.13737
49.On roadway crash	0.01748	-0.00737	-0.00712	0.00082	0.00318	-0.01003	0.0141	-0.00079	0.01249	-0.00197	-0.15003	0.06424	0.07545	0.0781	-0.13737	1
50.At intersection crash	-0.00008	0.03862	-0.0232	0.04365	0.08463	0.05239	-0.18624	-0.09326	0.01971	0.26665	0.26486	-0.03835	-0.01166	-0.05881	-0.3229	-0.73979
51.Off roadway crash	-0.02248	-0.03085	0.04319	-0.06264	-0.1219	-0.06096	0.24128	0.13073	-0.04527	-0.36745	-0.16369	-0.03507	-0.08735	-0.02864	0.63521	-0.3283
52.Dark	-0.03251	-0.02524	-0.11145	-0.27971	-0.38395	0.14981	0.69229	0.17622	0.0271	-0.22516	-0.07734	0.00189	-0.02338	-0.04404	0.25944	0.00734
53.Adverse conditions	-0.02122	0.00234	0.01144	-0.00049	-0.04168	-0.01375	0.05615	0.0205	-0.00905	-0.03054	0.0176	0.01479	0.00973	-0.02494	0.03882	-0.01461
54.Rural roads	-0.03428	-0.02605	0.03696	-0.04396	-0.05458	-0.03806	0.11883	0.08278	0.01664	-0.25298	-0.06609	0.05298	-0.01471	0.02206	0.27553	-0.02091
55.Animall factors	-0.01352	-0.02052	0.04634	-0.01455	-0.03712	0.00349	0.01372	0.00287	0.00484	-0.03323	0.00846	0.00642	-0.00966	-0.01743	0.01442	0.00664
56.Weatherl factors	-0.01745	-0.00193	0.01719	0.01436	-0.019	-0.00872	0.00297	0.01227	-0.01212	-0.0308	0.00988	0.01759	-0.0124	-0.01204	0.03487	-0.00852
57.Vision obstruction	-0.00758	-0.02607	0.01104	0.00895	-0.00961	0.00677	-0.01486	0.0032	0.00534	-0.01105	-0.00272	0.00826	-0.00903	-0.00523	0.01143	-0.00821
58.Vehicle factors	0.00795	-0.01163	0.00766	0.02127	-0.01041	0.00871	-0.02543	-0.00742	-0.01039	0.0181	-0.00629	-0.00866	-0.00481	-0.01032	0.00179	-0.00623
59.Road factors	0.08451	0.01516	0.03717	0.01282	-0.02021	-0.01461	-0.00783	0.00265	-0.00522	-0.02401	-0.02258	0.01103	0.00281	-0.0217	0.05218	-0.02473
60.Passenger	0.00893	0.00478	-0.06887	-0.0058	0.03419	0.01288	0.01221	0.06378	0.00264	-0.06227	0.04231	0.00293	0.02662	0.01487	0.01623	-0.00982
61.Male driver	0.00452	-0.01304	0.03162	-0.02997	-0.04594	-0.01278	0.07263	0.00396	0.00571	-0.01799	-0.05069	0.00632	-0.01746	-0.00786	0.05661	0.00256
62.Driver seatbelt not used	-0.00464	-0.01864	-0.00111	-0.02182	-0.04513	-0.00738	0.08694	0.03019	0.01765	-0.09661	-0.03497	-0.00501	-0.02461	-0.01391	0.09338	0.00031
63.Seatbelt do not wear	-0.00671	-0.00311	-0.01538	0.00687	0.01545	-0.01797	0.00743	0.01625	0.0028	-0.06656	-0.00242	-0.00012	-0.02824	-0.00724	0.05776	-0.00873
64.Occupants Ejection	-0.01104	-0.00467	-0.01223	-0.01366	-0.01712	-0.00789	0.05534	0.03805	-0.00297	-0.07239	-0.02771	-0.00466	-0.01536	-0.01211	0.04759	-0.01296
65.Occupants Front Seat	-0.00304	-0.00776	0.03432	-0.00818	-0.05103	0.00373	0.03582	-0.02005	-0.00438	0.02197	-0.02768	0.00152	-0.005	-0.00641	0.00879	-0.00371
66.Female occupants	-0.01396	0.01405	-0.00957	0.03442	0.04011	0.01675	-0.09455	-0.03003	-0.00246	0.05569	0.03103	-0.01049	0.00265	0.00529	-0.06782	0.00118

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Table A.4 (continued)

Variable	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
1.Young-adult distracted by cell phone	-0.01235	0.03587	0.07544	-0.0109	0.00578	-0.01597	-0.0144	-0.00025	-0.00757	-0.01369	-0.10667	0.03564	0.04069	-0.02395	0.0016	0.06936	0.01404
2.Young-adult distracted by other electronic devices	0.00514	-0.0073	0.00536	-0.00828	-0.00554	-0.00215	-0.00021	0.00733	-0.00916	0.00818	-0.06463	0.04169	0.00059	-0.02861	-0.01076	0.04202	-0.0115
3.Young-adult distracted In/on-vehicle	-0.00486	0.00929	-0.02032	-0.03256	0.01092	-0.01863	-0.02034	-0.00666	0.00268	-0.01081	-0.16312	0.05679	0.02566	-0.05804	-0.00732	0.10606	0.01878
4.External distraction Young-adult	0.0109	-0.02149	-0.02866	-0.0104	-0.03139	0.01865	0.00926	0.00275	-0.01232	-0.00048	-0.08689	0.04499	-0.00134	-0.03971	-0.01055	0.0565	-0.00446
5.Inattentive Young-adult	0.06765	-0.13219	-0.07325	0.01842	-0.10352	0.01765	0.01541	0.00461	0.00697	0.00568	-0.54444	0.30075	0.04148	-0.2644	0.00118	0.41901	-0.00223
6.Valid licensed	0.02483	-0.03116	-0.05664	-0.00441	0.03139	0.02603	-0.0042	-0.00354	-0.01428	0.00098	-0.05908	-0.01119	-0.03983	-0.05958	-0.0328	0.04806	0.03851
7.Restricted license	0.01244	-0.0152	-0.02551	0.01241	0.01076	0.00806	0.00618	0.00591	-0.0142	-0.00495	-0.03128	-0.05552	-0.00855	-0.01526	-0.00644	0.01573	0.07244
8.Alchohol/drug related	-0.12603	0.17443	0.30394	0.00728	0.07278	-0.02179	-0.00972	-0.01055	-0.02081	-0.00252	0.0052	0.06019	0.13911	0.07004	0.08903	0.02635	-0.06685
9.Vehicle age (Year 5 or newer)	0.00794	0.02475	0.02164	-0.00736	0.01882	-0.01497	0.01725	-0.00613	-0.0144	0.00159	-0.01348	-0.01324	-0.02256	-0.03154	-0.01266	0.01537	0.01205
10.Vehicle age (6-10 years)	0.01195	-0.00648	0.00592	-0.02183	-0.01719	0.00315	-0.00701	0.01167	-0.02164	0.00132	-0.01696	-0.05156	-0.01527	-0.01303	0.00243	0.00427	0.05833
11.Vehicle age (11-15 years)	-0.00982	0.00927	-0.0063	0.00374	0.02409	0.00235	0.00139	-0.00968	-0.01062	-0.00007	0.01881	-0.03981	-0.00423	0.0187	0.01281	-0.02324	0.03459
12.Vehicle age (Year 16 or older)	-0.00393	-0.01625	-0.01	0.01976	-0.01927	0.00252	-0.00396	0.00316	0.03509	-0.0019	0.00397	0.08802	0.02588	0.00786	-0.012	0.01101	-0.08852
13.Automobile	0.02849	-0.03307	0.03376	0.00765	-0.1199	-0.00267	0.00663	-0.00357	-0.0038	-0.00739	-0.02622	-0.09454	-0.07797	-0.08539	-0.08095	0.02827	0.11477
14.Van	-0.01456	-0.01507	-0.05544	-0.01077	-0.02095	0.00902	-0.00575	-0.00795	0.00258	0.00683	0.04745	-0.02334	-0.02317	0.02776	-0.01841	-0.06334	0.00143
15.Pickup-truck, camper-rv	-0.03556	0.05626	0.0035	0.00243	0.15678	-0.00601	0.01024	0.01347	0.02142	0.00559	-0.00549	0.20447	0.04733	0.02284	0.03134	0.03628	-0.2149
16.Sport vehicle	0.011	-0.00584	-0.018	-0.00183	0.00582	0.00743	-0.01362	-0.00384	-0.01947	-0.00156	0.02738	-0.09396	-0.0313	0.02076	0.00319	-0.04789	0.08412
17.Straight-following maneuver	-0.03628	0.08349	0.04338	0.00049	0.03702	-0.00853	0.00648	0.0116	0.00244	-0.00558	-0.02192	0.01835	0.03483	0.04885	0.0302	-0.00491	-0.01154
18.Turn/changing lanes maneuver	0.09467	-0.07979	-0.02392	0.00114	-0.05176	0.00621	-0.01343	-0.01771	-0.00498	-0.01313	0.02959	-0.01644	-0.03781	-0.03798	-0.02024	0.00307	0.00608
19.Avoiding maneuver	-0.03807	0.05107	-0.00036	-0.00202	0.05871	0.03536	0.01486	0.00875	-0.00193	0.02598	0.00689	-0.00012	0.01308	0.00309	-0.01306	0.00058	-0.0052
20.Stopped/parking/backing maneuver	-0.02199	-0.08628	-0.05789	-0.00954	-0.03258	-0.017	-0.0054	0.00099	0.00288	0.00923	-0.00138	-0.0173	-0.02495	-0.03	-0.01586	-0.00096	0.01951
21.No damage	0.02789	-0.03092	-0.03907	-0.00714	-0.02489	0.00178	-0.00429	-0.00564	-0.01112	-0.00369	-0.01498	0.03023	-0.00606	-0.01627	-0.00442	0.0123	-0.02334
22.Minor damage	0.09426	-0.16752	-0.10418	-0.03193	-0.11695	-0.01589	-0.01485	-0.01059	-0.0153	-0.01306	-0.00149	-0.00773	-0.07306	-0.0451	-0.04124	-0.0089	0.00387
23.Functional damage	0.08102	-0.1394	-0.09773	0.01713	-0.10965	0.00169	-0.01241	-0.01191	-0.00463	-0.01384	0.00567	-0.02698	-0.07343	-0.04713	-0.04746	-0.00697	0.03536
24.Disabling damage	-0.07432	0.12222	0.10667	0.01536	0.07456	0.01574	0.02113	0.00845	0.01922	0.02126	-0.01472	0.0045	0.05192	0.02745	-0.00045	0.01772	0.00446
25.Destroyed damage	-0.15969	0.27341	0.14771	-0.00207	0.23601	-0.00144	0.00735	0.01997	0.00092	0.00815	0.0279	0.0295	0.14368	0.10879	0.14364	-0.01523	-0.05489
26.Speed limit<35 mph	-0.03923	-0.1321	-0.00139	-0.02369	-0.19637	-0.03038	0.00609	0.00768	0.00027	-0.05843	0.01917	-0.01923	-0.02883	-0.00823	-0.0329	-0.01937	0.01107
27.Speed limit 35-60 mph	0.13732	-0.06045	-0.03943	-0.00188	0.01676	-0.00063	-0.03719	-0.0127	-0.00683	0.01288	-0.02689	-0.00017	0.00655	0.00025	0.00589	0.0173	0.01746
28.Speed limit>60 mph	-0.13521	0.24856	0.05241	0.03576	0.24334	0.04457	0.04654	0.00933	0.00668	0.06531	0.01593	0.02203	0.03122	0.01605	0.03922	-0.00214	-0.03904
29.Concrete roads	0.06306	-0.06402	-0.02291	0.00156	-0.14335	-0.01838	0.01955	0.00429	0.0165	0.0083	-0.0163	0.01199	-0.03289	-0.03904	-0.02275	0.02	-0.00152
30.Black top roads	0.00282	-0.01796	-0.01508	0.0063	-0.00359	0.00882	-0.02159	0.00005	-0.01338	-0.02076	0.0049	-0.01978	0.00826	0.01818	0.0004	-0.01659	0.01597
31.Gravel/brick roads	-0.14228	0.17605	0.0823	-0.01769	0.31565	0.02022	0.00688	-0.00908	-0.00497	0.02943	0.02331	0.01868	0.05256	0.04271	0.048	-0.00489	-0.03316
32.Wet/debris roads	0.00287	0.01814	0.06735	0.76242	0.00412	0.21203	0.13694	0.05943	0.01305	0.31225	0.01964	-0.00612	-0.02361	-0.03141	-0.00926	-0.00316	0.001
33.Curved road	-0.07625	0.17893	0.08255	0.00974	0.09848	0.03365	0.00403	0.01103	-0.0081	0.02677	0.01641	0.02314	0.04322	0.03201	0.05317	-0.00878	-0.04031
34.Work zone related	-0.00008	-0.02248	-0.03251	-0.02122	-0.03428	-0.01352	-0.01745	-0.00758	0.00795	0.08451	0.00893	0.00452	-0.00464	-0.00671	-0.01104	-0.00304	-0.01396
35.Multi lanes road	0.03862	-0.03085	-0.02524	0.00234	-0.02605	-0.02052	-0.00193	-0.02607	-0.01163	0.01516	0.00478	-0.01304	-0.01864	-0.00311	-0.00467	-0.00776	0.01405
36.5.00-9.00-morning	-0.0232	0.04319	-0.11145	0.01144	0.03696	0.04634	0.01719	0.01104	0.00766	0.03717	-0.06887	0.03162	-0.00111	-0.01538	-0.01223	0.03432	-0.00957
37.9.00-13.00-noon	0.04365	-0.06264	-0.27971	-0.00049	-0.04396	-0.01455	0.01436	0.00895	0.02127	0.01282	-0.0058	-0.02997	-0.02182	0.00687	-0.01366	-0.00818	0.03442
38.13.00-17.00-afternoon	0.08463	-0.1219	-0.38395	-0.04168	-0.05458	-0.03712	-0.019	-0.00961	-0.01041	-0.02021	0.03419	-0.04594	-0.04513	0.01545	-0.01712	-0.05103	0.04011
39.17.00-21.00-evening	0.05239	-0.06096	0.14981	-0.01375	-0.03806	0.00349	-0.00872	0.00677	0.00871	-0.01461	0.01288	-0.01278	-0.00738	-0.01797	-0.00789	0.00373	0.01675
40.21.00-5.00-night	-0.18624	0.24128	0.69229	0.05615	0.11883	0.01372	0.00297	-0.01486	-0.02543	-0.00783	0.01221	0.07263	0.08694	0.00743	0.05534	0.03582	-0.09455
41.Weekend	-0.09326	0.13073	0.17622	0.0205	0.08278	0.00287	0.01227	0.0032	-0.00742	0.00265	0.06378	0.00396	0.03019	0.01625	0.03805	-0.02005	-0.03003
42.Head On crash	0.01971	-0.04527	0.0271	-0.00905	0.01664	0.00484	-0.01212	0.00534	-0.01039	-0.00522	0.00264	0.00571	0.01765	0.0028	-0.00297	-0.00438	-0.00246
43.Rear end crash	0.26665	-0.36745	-0.22516	-0.03054	-0.25298	-0.03323	-0.0308	-0.01105	0.0181	-0.02401	-0.06227	-0.01799	-0.09661	-0.06656	-0.07239	0.02197	0.05569
44.Angle crash	0.26486	-0.16369	-0.07734	0.0176	-0.06609	0.00846	0.00988	-0.00272	-0.00629	-0.02258	0.04231	-0.05069	-0.03497	-0.00242	-0.02771	-0.02768	0.03103
45.Opposite direction crash	-0.03835	-0.03507	0.00189	0.01479	0.05298	0.00642	0.01759	0.00826	-0.00866	0.01103	0.00293	0.00632	-0.00501	-0.00012	-0.00466	0.00152	-0.01049
46.Same direction crash	-0.01166	-0.08735	-0.02338	0.00973	-0.01471	-0.00966	-0.0124	-0.00903	-0.00481	0.00281	0.02662	-0.01746	-0.02461	-0.02824	-0.01536	-0.005	0.00265
47.Backed into crash	-0.05881	-0.02864	-0.04404	-0.02494	0.02206	-0.01743	-0.01204	-0.00523	-0.01032	-0.0217	0.01487	-0.00786	-0.01391	-0.00724	-0.01211	-0.00641	0.00529
48.Single-vehicle crash	-0.3229	0.63521	0.25944	0.03882	0.27553	0.01442	0.03487	0.01143	0.00179	0.05218	0.01623	0.05661	0.09338	0.05776	0.04759	0.00879	-0.06782
49.On roadway crash	-0.73979	-0.3283	0.00734	-0.01461	-0.02091	0.00664	-0.00852	-0.00821	-0.00623	-0.02473	-0.00982	0.00256	0.00031	-0.00873	-0.01296	-0.00371	0.00118
50.At intersection crash	1	-0.3843	-0.15894	-0.0097	-0.23539	-0.02238	-0.01244	-0.00637	0.0045	-0.01628	-0.00044	-0.03935	-0.07685	-0.03671	-0.05526	-0.00388	0.04581
51.Off roadway crash	-0.3843	1	0.21218	0.03452	0.35554	0.02381	0.0285	0.0207	0.00292	0.05876	0.01504	0.05147	0.10503	0.06141	0.09682	0.00938	-0.06488
52.Dark	-0.15894	0.21218	1	0.0843	0.11186	0.03001	0.00798	-0.00509	-0.01169	0.00607	0.00943	0.06841	0.06147	-0.01523	0.03685	0.04279	-0.07954
53.Adverse conditions	-0.0097	0.03452	0.0843	1	0.02119	0.27731	0.18044	0.08586	0.01484	0.23397	0.01169	0.00599	-0.01497	-0.03944	-0.0037	0.0094	-0.01224
54.Rural roads	-0.23539	0.35554	0.11186	0.02119	1	0.07155	0.02976	0.01666	0.00447	0.04833	0.03829	0.02523	0.10542	0.10142	0.09482	-0.02601	-0.05629
55.Animall factors	-0.02238	0.02381	0.03001	0.27731	0.07155	1	-0.01519	-0.0066	-0.00431	0.18063	-0.00453	0.01165	-0.00085	-0.0148	-0.00785	0.00702	-0.01011
56.Weatherl factors	-0.01244	0.0285	0.00798	0.18044	0.02976	-0.01519	1	-0.00392	-0.00773	0.16613	0.00484	0.00057	-0.00385	-0.00361	-0.00908	-0.00545	0.00129
57.Vision obstruction	-0.00637	0.0207	-0.00509	0.08586	0.01666	-0.0066	-0.00392	1	-0.00336	0.07922	0.00097	0.0021	-0.00133	-0.00734	-0.00395	0.00728	-0.00449
58.Vehicle factors	0.0045	0.00292	-0.01169	0.01484	0.00447	-0.00431	-0.00773	-0.00336	1	0.01409	0.0051	0.00936	-0.00217	0.00052	0.00654	0.00347	-0.00947
59.Road factors	-0.01628	0.05876	0.00607	0.23397	0.04833	0.18063	0.16613	0.07922	0.01409	1	0.01061	0.00469	0.00394	0.00803	0.00708	-0.01114	-0.00935
60.Passenger	-0.00044	0.01504	0.00943	0.01169	0.03829	-0.00453	0.00484	0.00097	0.0051	0.01061	1	-0.49513	-0.11484	0.38071	0.00683	-0.55019	0.03126
61.Male driver	-0.03935	0.05147	0.06841	0.00599	0.02523	0.01165	0.00057	0.0021	0.00936	0.00469	-0.49513	1	0.12636	-0.14779	0.03119	0.32193	-0.76609
62.Driver seatbelt not used	-0.07685	0.10503	0.06147	-0.01497	0.10542	-0.00085	-0.00385	-0.00133	-0.00217	0.00394	-0.11484	0.12636	1	0.53428	0.30319	0.07467	-0.07425
63.Seatbelt do not wear	-0.03671	0.06141	-0.01523	-0.03944	0.10142	-0.0148	-0.00361	-0.00734	0.00052	0.00803	0.38071	-0.14779	0.53428	1	0.22887	-0.54374	-0.02189
64.Occupants Ejection	-0.05526	0.09682	0.03685	-0.0037	0.09482	-0.00785	-0.00908	-0.00395	0.00654	0.00708	0.00683	0.03119	0.30319	0.22887	1	-0.01736	-0.03475
65.Occupants Front Seat	-0.00388	0.00938	0.04279	0.0094	-0.02601	0.00702	-0.00545	0.00728	0.00347	-0.01114	-0.55019	0.32193	0.07467	-0.54374	-0.01736	1	-0.01073
66.Female occupants	0.04581	-0.06488	-0.07954	-0.01224	-0.05629	-0.01011	0.00129	-0.00449	-0.00947	-0.00935	0.03126	-0.76609	-0.07425	-0.02189	-0.03475	-0.01073	1

Note: The highlighted cell indicates correlation among pair of explanatory variables found at Correlation Coefficient= 0.6 level.

Appendix B – Survey Form

Civil Engineering Department at Kansas State University is conducting a study to understand the habits and attitudes of young drivers in regards to driver distraction. No personal information will be collected and your participation is completely voluntary. Data collected will be used for research purposes only. If you have any questions, please contact the PhD student in CE at: alfallai@ksu.edu

Age (Yrs):

○ 15 ○ 16 - 17 ○ 18 - 20 ○ 21 - 24 ○ 25 - 26 ○ 27 or more

Gender:

○ Male ○ Female

GENERAL INFORMATION

1. How often do you drive a motor vehicle?

○ Every day ○ Almost every day ○ Few days a week ○ Few days a month ○ Few days a year

○ Never [SKIP TO Q25]

2. What type of vehicle did you recently drive?

○ Car ○ Van or minivan ○ Motorcycle ○ Pickup truck ○ Sport utility vehicle ○ Other (.....)

3. What is the highest level of education you have completed?

○ Some high school ○ Some college ○ Some graduate school

4. What is your approximate annual household income?

○ Less than $25K ○ $25K to less than $50K

○ $50K to less than $100K ○ $100K or more

○ Don't Know

5. What is your zip code? (.....)

OWNERSHIP OF MOBILE ELECTRONICS

6. Do you CURRENTLY own any of the following devices? (Please select all that apply)

☐ A cell phone or smartphone ☐ In-car navigation systems

☐ Other electronic devices (e.g., portable music player and laptop computer)

7. How often do you do the following activities?

Description	Always	Almost always	Sometimes	Seldom	Never
Talk to passengers while driving	○	○	○	○	○
Eat or drink while driving	○	○	○	○	○
Read a book or newspaper while driving	○	○	○	○	○
Talk or interact with children in the back seat while driving	○	○	○	○	○
Do personal grooming while driving	○	○	○	○	○
Change radio stations or searching for CDs while driving	○	○	○	○	○
Use your cell phone for driving directions	○	○	○	○	○
Use a navigation system while driving	○	○	○	○	○

ACCEPTING AND MAKING PHONE CALLS WHILE DRIVING

8. How often do you ACCEPT a phone call while driving?

○ Always ○ Almost always ○ Sometimes ○ Seldom ○ Never [SKIP TO Q12]

9. Under what situations do you accept a phone call while driving? (Please select all that apply)

☐ Importance of the call ☐ Known caller

☐ Accessibility of the phone ☐ No traffic congestion

☐ No adverse weather conditions ☐ No visible police officers

☐ Work-related call ☐ Driving on roads with low speed limits

☐ Getting driving directions ☐ Other (.....)

10. When driving, do you usually…

☐ Accept a phone call and complete the conversation while driving

☐ Ask your passenger to accept the phone call

☐ Accept a phone call and tell the caller you will call back later

☐ Accept a phone call and then pull over to a safe place to complete the conversation

☐ Pull over to a safe place and then accept the phone call

11. While driving, do you usually accept a phone call using: (Please select all that apply)

☐ Hands-free device ☐ Hand-held device ☐ Other (.....)

12. How often do you MAKE a phone call while driving?

○ Always ○ Almost always ○ Sometimes ○ Seldom ○ Never [SKIP TO Q17]

13. Under what situations do you make a call while driving? (Please select all that apply)

☐ Importance of the call ☐ Getting driving directions

☐ No traffic congestion ☐ Safe to make a call

☐ In an emergency ☐ No adverse weather

☐ Accessibility of the phone ☐ No visible police officers

☐ Work-related call ☐ Driving on roads with low speed

☐ Other (.....)

14. While driving, do you usually make a phone call using: (Please select all that apply)

☐ Manual dialing

☐ Voice-dial

☐ Other (e.g., speed dial or saved numbers)

15. How do you think your driving is affected when you are accepting or making a phone call? (Please select all that apply)

☐ No effects ☐ Drive at low speed ☐ Look in mirrors more frequently

☐ Increase gap distance from front vehicle ☐ Reduce changing travel lanes

☐ Avoid changing travel lanes ☐ Drift off the lane or road

☐ Use turn signal less frequently

☐ Other (……)

16. Under what circumstances you would never accept or make a phone call while driving? (Please select all that apply)

☐ Merging with traffic ☐ Adverse weather conditions

☐ Visible police officers ☐ Driving on roads with high speed limits

☐ Driving in unfamiliar roads ☐ Driving with a baby on board

☐ Driving on curved roads ☐ Driving in school zones

☐ Driving in work zones ☐ Driving at nighttime

☐ Driving with adult passengers ☐ Driving in neighborhoods or parking lots

☐ Other (……)

TEXTING OR E-MAILING WHILE DRIVING

17. How often do you READ messages while driving?

○ Always ○ Almost always ○ Sometimes ○ Seldom ○ Never

18. How often do you SEND messages while driving?

○ Always ○ Almost always ○ Sometimes ○ Seldom ○ Never [SKIP TO Q23]

19. When driving, do you usually…

☐ Continue to drive while sending a message

☐ Send a message while stopping at a red light or stop sign

☐ Ask your passenger to send the message

☐ Use a voice command feature (speech dictation) to send the message

☐ Pull over to a safe place and then send the message

20. Under what situations do you send a message while driving? (Please select all that apply)

☐ Importance of the message ☐ No traffic congestion

☐ Safe to send a message ☐ Getting driving directions

☐ No adverse weather conditions ☐ Driving on roads with low speed limits

☐ No visible police officers ☐ Work-related

☐ In an emergency ☐ Other (……)

21. How do you think your driving is affected when you are sending messages? (Please select all that apply)

- ☐ Drive at low speed
- ☐ Drift off the lane or road
- ☐ Look in mirrors more frequently
- ☐ Reduce changing travel lanes
- ☐ Other (.....)
- ☐ Increase gap distance from front vehicle
- ☐ No effects
- ☐ Avoid changing travel lanes
- ☐ Apply the brakes suddenly

22. Under what circumstances you would never send a message while driving? (Please select all that apply)

- ☐ Merging with traffic
- ☐ Visible police officers
- ☐ Driving with a baby on board
- ☐ Driving on curved roads
- ☐ Driving at nighttime
- ☐ Driving with adult passengers
- ☐ Other (.....)
- ☐ Adverse weather conditions
- ☐ Driving on roads with high speed limits
- ☐ Driving in unfamiliar roads
- ☐ Driving in school zones
- ☐ Driving in work zones
- ☐ Driving in neighborhoods or parking lots

<u>EDUCATIONAL MESSAGES</u>

23. Recently, have you seen or heard educational messages that warn about the potential hazards of using a cell phone (e.g., talking or sending/reading text messages) while driving?

○ Yes ○ No ○ Don't Know

24. An average, how many seconds do you think drivers can take their eyes off the road before crash occurrence?

ENTER VALUE: _____

○ Don't know

25. As a passenger, how safe you would feel when your driver was doing the following distracting activities?

Description	Very unsafe	Unsafe	Safe	Very safe	Don't know
Talking to passengers	○	○	○	○	○
Eating or drinking	○	○	○	○	○
Talking on a hand-held cell phone	○	○	○	○	○
Talking on the phone with a hands free device	○	○	○	○	○
Reading a book or newspaper	○	○	○	○	○
Reading messages	○	○	○	○	○
Sending messages	○	○	○	○	○
Dealing with children in the back seat	○	○	○	○	○
Doing personal grooming	○	○	○	○	○
Distracting in the vehicle items (i.e., adjusting the car radio, tape, or CD player)	○	○	○	○	○
Singing	○	○	○	○	○
Using a laptop computer	○	○	○	○	○
Using a music player	○	○	○	○	○
Using a navigation system	○	○	○	○	○
Watching a movie	○	○	○	○	○

26. As a passenger, how often do you do or say something to your distracted driver to stop talking on a hand-held cell phone while driving?

○ Always ○ Almost always ○ Sometimes ○ Seldom ○ Never ○ Don't know

27. What do you do or say?

(.....)

28. As a passenger, how often do you do or say something to your distracted driver to stop texting while driving?

○ Always ○ Almost always ○ Sometimes ○ Seldom ○ Never ○ Don't know

29. What do you do or say?

(.....)

30. In the last year, has your frequency of talking on cell phone while driving changed? [SKIP TO Q32 IF THE ANSWER NOT <u>DECREASED</u>]

○ Increased ○ Decreased ○ No change

○ Never talk on cell phone while driving ○ Don't know

31. Is your frequency of talking on cell phone while driving <u>decreased</u> due to: (Please select all that apply)

☐ Increased awareness about the hazards of using a cell phone while driving

☐ Cell phone use while driving bans

☐ Been in a crash

☐ Other (.....)

32. In the last year, has your frequency of texting while driving changed? [SKIP TO Q34 IF THE ANSWER NOT DECREASED]

○ Increased ○ Decreased ○ No change

○ Never texting while driving ○ Don't know

33. Is your frequency of texting while driving decreased due to: (Please select all that apply)

☐ Increased awareness about the hazards of using a cell phone while driving

☐ Cell phone use while driving bans

☐ Been in a crash

☐ Other (.....)

DISTRACTED DRIVING LAWS

34. Do you have a law in your area banning hand-held cell phone use while driving?

○ Yes ○ Yes, I think so ○ No ○ Don't Know

35. Do you have a law in your area banning texting while driving?

○ Yes ○ Yes, I think so ○ No ○ Don't Know

36. Do you support a Kansas law banning hand-held cell phone use while driving that applied to some cities?

○ Yes ○ No ○ Don't Know

37. Do you support a Kansas law banning texting while driving?

○ Yes ○ No ○ Don't Know

38. As a driver, have you ever had a traffic violation because of?

○ Hand-held cell phone use (e.g., talking or sending/reading text messages)

○ Speeding [SKIP TO Q40] ○ Other [SKIP TO Q40] ○ Never [SKIP TO Q40]

39. As a driver, have you ever had a traffic violation that resulted in a ticket or warning because of using a handheld cell phone (e.g., talking or sending/reading text messages) while driving?

○ Yes ○ No ○ Don't Know

EXPOSURE TO CRASHES AND DISTRACTION-RELATED CRASHES

40. As a driver, have you been in a crash or near-crash during the last year?

○ Yes - near-crash ○ Yes - crash ○ No [Survey End] ○ Don't Know [Survey End]

41. As a driver, have you been in a crash or near-crash because of using a cell phone (e.g., talking or sending/reading text messages) during the last year?

○ Yes ○ No ○ Don't Know

"Thank you"

Appendix C – IRB Approval Letter

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Sunanda Dissanayake
Civil Engineering
2128 Fielder

Proposal Number: 8103

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 03/10/2016

RE: Approval of Proposal Entitled, "Survey and Crash Analysis to Identify Teen and Young Adult Drivers' Distractions in Kansas."

The Committee on Research Involving Human Subjects has reviewed your proposal and has granted full approval. This proposal is **approved for one year from the date of this correspondence, pending "continuing review."**

APPROVAL DATE: 03/10/2016

EXPIRATION DATE: 03/10/2017

Several months prior to the expiration date listed, the IRB will solicit information from you for federally mandated **"continuing review" of the research.** Based on the review, the IRB may approve the activity for another year. **If continuing IRB approval is not granted, or the IRB fails to perform the continuing review before the expiration date noted above, the project will expire and the activity involving human subjects must be terminated on that date. Consequently, it is critical that you are responsive to the IRB request for information for continuing review if you want your project to continue.**

In giving its approval, the Committee has determined that:

☒ There is no more than minimal risk to the subjects.
☐ There is greater than minimal risk to the subjects.

This approval applies only to the proposal currently on file as written. Any change or modification affecting human subjects must be approved by the IRB prior to implementation. All approved proposals are subject to continuing review at least annually, which may include the examination of records connected with the project. Announced post-approval monitoring may be performed during the course of this approval period by URCO staff. Injuries, unanticipated problems or adverse events involving risk to subjects or to others must be reported immediately to the Chair of the IRB and / or the URCO.

203 Fairchild Hall, Lower Mezzanine, 1601 Vattier St., Manhattan, KS 66506-1103 | 785-532-3224 | fax 785-532-3278 | k-state.edu/research/comply | comply@ksu.edu